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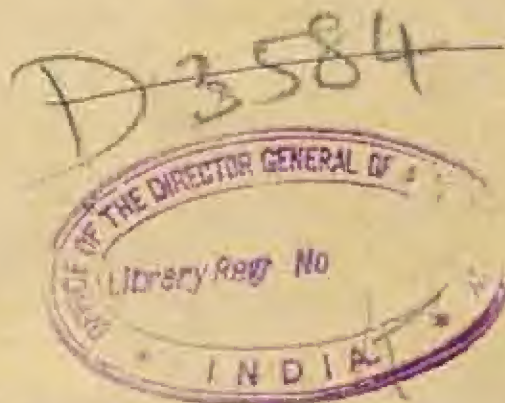


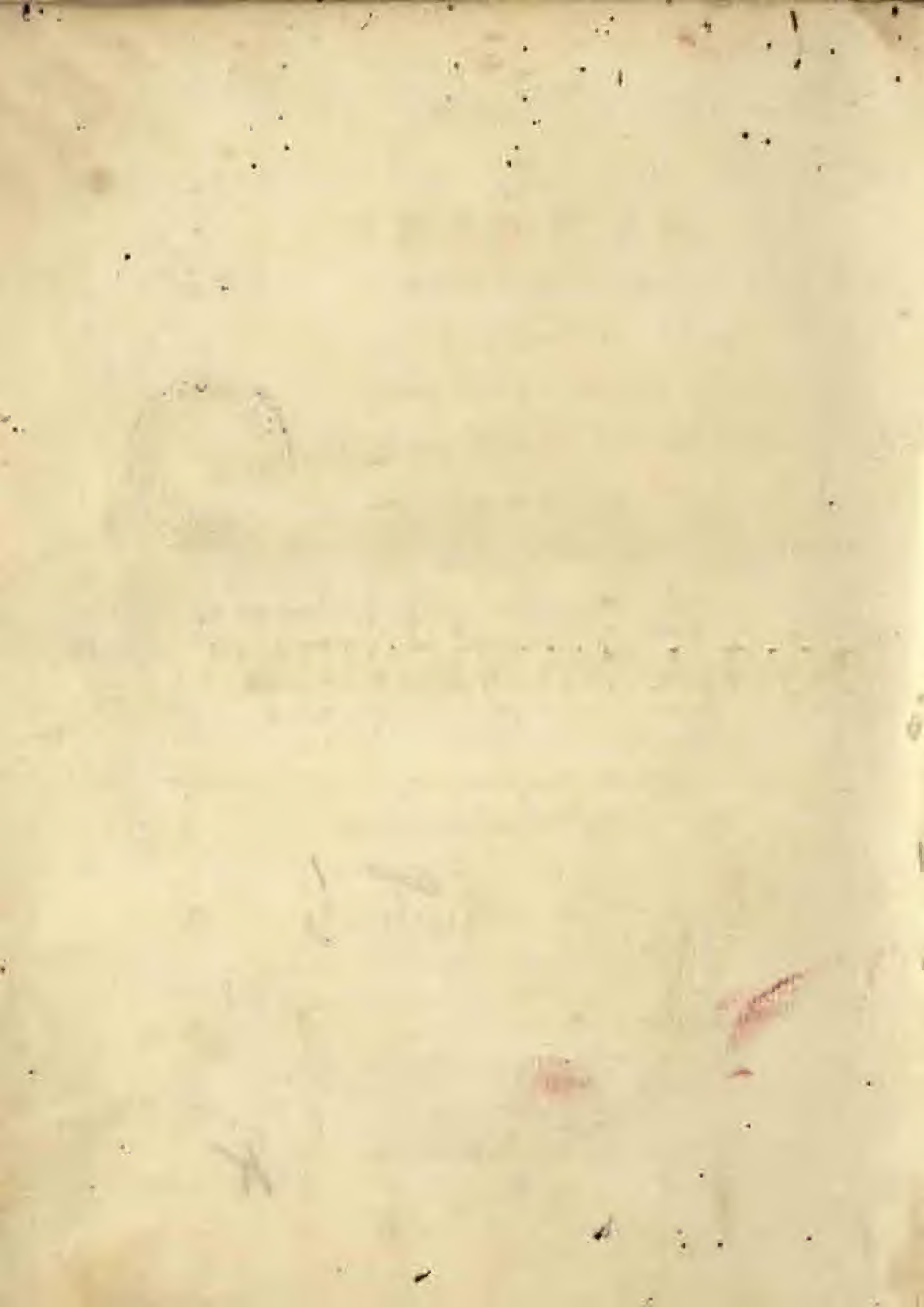
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KALA SANKALITA.





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A COLLECTION

OF

MEMOIRS

ON THE VARIOUS MODES

ACCORDING TO WHICH

THE NATIONS OF THE

SOUTHERN PARTS OF INDIA

34963 DIVIDE TIME:

TO WHICH ARE ADDED,

Three General Tables, wherein may be found by mere inspection the beginning, character, and roots of the Tamul, Tellinga, and Mahommedan Civil Years, concurring, viz. the two former with the European Years of the XVIIth, XVIIIth and XIXth Centuries, and the latter with those from A. D. 622 (A. H. 1) to 1900.

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Warr
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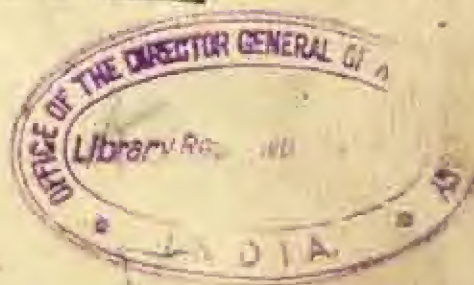
----- Si fortè lepos austeri canentes
Deficit, eloquio victi, re vincimus ipsâ.

MADRAS:

PRINTED AT THE COLLEGE PRESS.—1825.



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TO THE
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UNDER WHOSE AUSPICES AND PATRONAGE
IT WAS UNDERTAKEN AND COMPLETED,

This Work,
IS RESPECTFULLY INSCRIBED

BY

The Author.

MADRAS, 26th February 1825.



PREFACE.

THE present work, which has assumed a variety of shapes since it was first undertaken, was originally intended for the sole use of the Honorable Company's College of Fort. St. George. It was subsequently conceived that some of its Tables might be of service to Gentlemen employed in the Revenue and Judicial departments, and on that account the original manuscript (as far as it then extended) was purchased by Government in the year 1815: since that time it was considerably augmented, with a view to render it more deserving of the patronage it had received.

The irregular progress of the composition of these Memoirs, has unavoidably occasioned a defect in the arrangement of their parts, which the Author found subsequently impossible to remove entirely, and on that account he claims the reader's indulgence. The various employments which he held in His Majesty's Civil and Military services in different parts of the world, during eleven years that this work was in hand (though he admits, an insufficient excuse) may perhaps abate the rigour of criticism on what refers to style and method; and more than any other consideration, the circumstance of its having been originally undertaken at the call of private friendship and continued, after the object of it had ceased to exist, with the sole view of being serviceable to a public institution, without any prospective advantage to himself, will, the Author hopes, save him from the reproach of having rashly intruded his imperfect labours on the attention of the public.

The results of the present research can be of no sort of use to European Astronomy: they were derived from systems which we see no where supported by recorded observations, or modified (for several centuries past) by improved

theories. The Author begs it further to be understood, that these Memoirs are not designed to support or combat any doctrine or conjecture, on the past and present state of Hindu Astronomy; their chief object being merely to explain the various modes according to which the Natives of India divide *time*, in these southern provinces, and to render their Kalendars intelligible. These may, therefore, be properly considered rather as instruments contrived for Chronological purposes, than as Astronomical Tracts.

Each Memoir contains several Tables intended to abridge the tedious process of converting dates proposed according to European style, into the corresponding Tamul, Tellinga, and Mahomedan time, and vice versa.

The expediency of such an attempt was originally suggested by the late Mr. F. W. Ellis, Senior Member of the Board of Superintendence of the College of Fort St. George, who conceived that a work which would facilitate the comparison of the European and Hindu Chronologies, would be attended with the double advantage of relieving the Officers of Government from much uncertainty in the administration of public affairs, and at the same time of affording to the learned Natives of this part of India (some of whom are tolerably proficient in the English language) the means of acquiring the knowledge of our own methods of fixing epochs and recording events.

This conception was worthy of a Gentleman so well known to the Indian public for his powers of research, and enlarged views of administration; but he was not aware of the difficulties which surrounded its execution. At the time when he first proposed it to the Author, the knowledge of Hindu Astronomy was almost entirely extinct among the Natives of the Carnatic, and with very few exceptions, totally neglected by the Europeans. Some straggling Astrologers attached to the service of opulent Natives, and some obscure Almanac makers might, it is true, occasionally furnish a table, and a formulæ, such as were collected by La Loubère, Father Duchamp, Father Beschi, Le Gentil and others; but none were to be found capable of leading the Author into the obscure paths of Hindu Chronology or Astronomy; a case very different

from that of our learned cotemporaries in Bengal, who, whilst we were gleanings in a withered field for a few decayed materials, gathered ample stores from the collections of learned Natives and Brahminical institutions, not unassisted by well informed *Pundits*, *Mulavies* and *Jyautish Sastras*.

The labour of collecting and verifying the materials on which these Memoirs are founded was, therefore, much more considerable than was anticipated, and time and perseverance alone have enabled the Author to erect his work on authentic information.

The present production, if it fails in other respects, will at least serve to show nearly the present extent of our knowledge in Hindu Astronomy in these southern provinces, and in the absence of every other merit, the Author may perhaps be suffered to claim some credit for having been the first in the Carnatic, since the days of Beschi and Le Gentil who, unassisted, has endeavoured to draw the public attention on a subject of this nature.

Independently of his wishes to gratify the curiosity of Europeans, the Author had also in view (perhaps in a greater degree) to familiarize the learned Natives with the use of Tables constructed and disposed in the manner of those of the European Mathematicians; and also to reconcile them to the idea of brevity and expedition in computations, to which they are singularly averse, from a supposition that nothing can replace the entire exposition in figures of every part of the problems they are to resolve. In this attempt he found himself more successful than he had a right to expect—his Tables for the *Ahargana* of the Sun, Moon and Jupiter, intended to reduce the endless multiplications and divisions of the *Sastra* rules to addition and subtraction, and to elicit, by a short process, the number of days, and fractions of days expired from a given epoch to the time for which the computation is made, after due examination by the best informed *Jyautish Sastras* in Madras, have been pronounced “equivalent to the respective rules which they were intended to abridge,” and they have manifested an intention of using them in future.

To the skill required for constructing the Tables referred to, the Author does not attach the least importance; these wanted neither depth of science nor ingenuity of contrivance; but what has gratified him was, to find a prejudice shaken which stood in the way of improvement, and a wish on the part of the better classes of the Natives (long since manifested in Bengal) to become better acquainted, than they were hitherto satisfied to be, with European doctrines and knowledge.

In order to avoid the risk of entering into scientific controversy, the Author has carefully avoided all dissertations which might lead him out of the confined scope which he has prescribed to himself. Whether modern (or syderal) Astronomy was instituted so near to our times as the year of Christ 538, as some pretend, or whether its origin lies concealed in the obscurity of time, he shall not consider; but will expound the operation of the system now universally in use in India, as if it had ruled all past ages, and were to continue to do so to the end of time.

This assumption, although manifestly imaginary will, however, suffice for immediate purposes; for what public record can there fall under the cognizance of the Magistrate or of the Collector, that should bear an older date than the year of Christ 538?—and where is the probability that the ancient Tropical system (which is said to have been superseded at that epoch) will ever return into use among the Natives?

For the same reason, the Author will abstain from canvassing the opinions of learned cotemporaries on certain astronomical notions, which are affirmed and denied with equal confidence.

Whether, for instance, the supposed libration of the equinoctial points about the beginning of the fixed Hindu Zodiac (absurd as that notion no doubt is) proceeds from the error of European Scholiasts on certain passages of the Surriah, Vasis'tha, and Varasanita Siddhanta; or whether that doctrine be actually expressed with various modifications in the respective texts, is what he shall not pretend to determine: but, as Mr. Davis found that notion

established among the Jyautish Sastras at Benares, in the year 1786; Mr. Andrew Scott in the Northern Circars, in 1790, and the Author in the Carnatic, in 1814, without any difference of opinion among the Native Mathematicians, he thought himself justified in a *practical work*, when speaking of the Indian *precessional variation*, to use their own language; a compliance which is subject to no inconveniency, because even if it be supposed that the precession ceased to be retrograde in the year before Christ 6701, (as some will have it), the same theory does not admit that it can resume the same course before A. D. 7699, an Epoch so remote from the times in which we live, that it is a matter of perfect indifference to his present object, which of the contending parties has best understood the text; the more so, that the motion of the Equinoxes is supposed variable in neither doctrines, and that even those who support the system of libration admit neither decrement, nor increment, as it approaches to or recedes from its limits.

As this work rests on three distinct doctrines, viz: 1^o What relates to the Tamul Solar year on the authority of the *Aria Siddhanta*. 2^o What refers to the Luni-solar Astronomical year and Kalendar of the *Telliogas*, on that of the *Surriah Siddhanta*. 3^o and lastly, what concerns the Mahomedan Kalendar on the Arabic system,—it was found indispensable to divide it into several parts.

The whole collectively taken, was denominated by some learned friends *Kala Sankalita*, a Sungscrite word signifying the doctrine of times. It presents (as far as the Author knows) the first attempt that was made in India to investigate and explain the elements of Hindu Astronomical Chronology, and to disclose to Europeans the contents and structure of those humble annual Kalendars which, written on palmyra leaves have, during nearly two centuries, been sold under their eyes without their even suspecting the skill and labour which their computation required.

The first Memoir, called a Key to the *Madhyama Saura Mana*, contains an exposition of the mean Solar Sydereal year used by the Tamul inhabitants of the Peninsula of India. It shows 1^o How its beginning, that of each of its months, and the rank of every day in the year and month, are to be determined,

according to 'Sydereal (by some called improperly Astronomical) or Civil account. 2^o How any date proposed in either of the old or new European styles may be converted into its corresponding 'Tamul date or *theidy*, and vice versa. There will be found at the end of the Volume certain Tables for resolving most cases referring to Solar time, without having recourse to the endless process of Native Astronomers.

Some parts of these theories, and of the three first Tables, were extracted from Father Beschi's tract on the 'Tamul time, which forms the 3^o Appendix to his Dictionary.

The Key to the *Madhyama Saura Mana* forms an indispensable introduction to the second Memoir, as it is impossible to compute the end of any Luni-solar year, month and day, without a previous knowledge of the concurring Solar divisions of time, and as both are usually registered together in the *Chandra Panchangum*, or Luni-solar Kalendar. The Tables annexed to the first Memoir for the commutation of dates, will also serve for the second, with this only reservation, that if the date proposed be expressed solely in terms of Lunar tidhis, which depend on the Sun and Moon's relative motion (a case of very rare occurrence), then the Solar concurring day must be expounded by means not conveyed in the said Tables.

Two General Tables are given at the end of the Volume, the first of which refers principally to the Memoir on the Solar year. Besides other articles, it exhibits the beginning of each 'Tamul year reckoned from the beginning of the Cali yug, and the birth of Salivahana, concurring with the Christian years of the XVIIIth, XVIIIth and XIXth centuries, according to the Julian and Gregorian styles, as far down as A. D. 1752, and to the latter only down to 1900. The Dominical Letters according to the two styles follow, and the initial seræ and monthly dates, of beginning, as well as the roots of each year, are given in the two last columns, according to Hindu Sydereal and Civil accounts.

This Table gives also the names and ranks of the years of Jupiter's Cycle

of 60 years, agreeably to the *three* accounts of the *Surriah Siddhanta*, the *Jyantistava*, and that of the *Tellingas*, who make Jupiter's and the Solar year, equal : The two first accounts being followed in Bengal and the last in the Peninsula.

The numerals of the years of the Cycle of 90 years, used in the *Tanjore*, *Travancore*, *Madura* and *Tinnivelly* provinces, are inserted in the 6th column.

In the second General Table will be found, the Christian years of the *XVIIth*, *XVIIIth* and *XIXth* centuries, with the concurring Luni-solar years of the *Caliyug*, their character, i.e. whether the year be a common or an intercalary one, the *seriæ* and monthly dates of the last conjunction of the year, when the ensuing year begins. The date of the same according to the *Tamul Kalendars*, and the Solar and Luni-solar *Ahargana* from which is deduced the juxtaposition of the beginning of the respective Solar and Luni-solar years. This Table, therefore, furnishes by mere inspection, the commencement of the Luni-solar year of the three centuries most wanted in present times, showing the day of the week, the monthly (*Gregorian*) date, and the *Tamul Solar* date of the same ; and furthermore supplies the two elements first wanted for computing the beginning of every Solar and Luni-solar month and *tidhi* in any of the said proposed years.

The second Memoir, entitled a *Key to the Siddhanta Chandra Mana* (as it is called in the Peninsula), contains the theory and construction of the Luni-solar Astronomical year, on which hangs the whole fabric of Hindu Astronomy.

In analyzing and unfolding the construction of a *Kalendar* which seems to have been invented for the purpose of perplexing the Astronomer and confounding the Chronologist, the Author confesses that he had often to guess before he could demonstrate, and that he has been long groping in a dark and pathless heath before he could see clear before him, and decipher the columns of the common *Patra*, or *Panchangum*, which is sold and read in every village of India ; for although the system on which it rests rules all the astronomical computations of the *Hindoos*,—governs their religious festivals and sacrifices,—the

expiatory ceremonies for the dead,—the agricultural dispositions which depend on the contingencies of the seasons,—and lastly, the endless train of superstitious observances, the epochs of which are determined by the science of Astrology (alike cherished by the Hindu and the Mussulman), yet the leading features of the Luni-solar Kalendar, are to this day much less understood by the Europeans who reside in this part of India, than any other measure of time used in any part of the world.

If it be considered that the doctrines on which these humble Kalendars are calculated, have from time immemorial ruled the Chronology of many civilized and wealthy nations, the subject of the second Memoir may not be deemed undeserving of the attention of the votaries of science. Its subdivisions treat of the following matter, and have in view, 1^o To explain the principle and construction of the Luni-solar Kalendar, as it would be calculated for Lanka (if such a place were in existence), under the first Meridian and the Equator, and then to reduce the same to some other geographical position.

In the first division of the second Memoir, the computation of the different elements is explained according to the rules of the *Surriah Siddhanta*: a whole section is devoted to Hindu Gnomonics, the problems of which are indispensable for finding the true time of the circumstances of the year at any place which has longitude and latitude. The Trigonometrical demonstrations of the problems by which the Right Ascension, Declination, Longitude, Zenith Distance and Amplitude of the Asters are determined, will be found with Table XXX, page 36, 37 & 38 of the Tables, at the end of the Memoirs.

2^o To determine the periods of mean intercalations from which the true intercalary or expunged months due to certain Luni-solar years may be deduced.

3^o The method of computing the various collateral articles of the Luni-solar Kalendar, according to the Rules and Tables of *Vaxilala Carchinna*, an Indian Astronomer whose works are much esteemed and used in Tellingana.

This latter Section is exclusively the work of the late Mr. Andrew Scott, a Gentleman no less to be regretted for his amiable qualities, the uprightness of

his mind, and the simplicity of his manners, than for his extensive information in every branch of knowledge, and the liberality with which he imparted it to those who were qualified to benefit by his instructions. Some parts of this commentary might perhaps have been enlarged with a view to render it more accessible to persons not versed in Hindu Astronomy: but the author would have thought himself guilty of presumption had he pretended to improve any production that came from one whom he knew to be so eminently versed in the science.

The Tables which accompany the second Memoir, were procured from various sources. Those of Maracanda were borrowed from Mr. Davis' Memoir on the Astronomical computations of the Hindus. The Solar and Lunar Tables, also those of the Planets, are due to Mr. Scott's kindness. The Tables used for computing the Luni-solar Kalendar according to the precepts of Solar Astronomy (otherwise called the Vakiam process in the Peninsula) were furnished by Ruttani Audi Sashya Sastri, a Brahmin employed as Native Astronomer in the College of Fort St. George, to whom the Author owes a great part of the information he possesses on the construction of the Luni-solar Kalendar.

These three Tables are, he supposes, the same as were given to the public many years ago, by Father Duchamp, though he is not perfectly certain of the fact. They are now very scarce in this part of India, for it was with difficulty that those referred to were procured. The rest of the Tables were either obtained from native Indians, or constructed by the Author as occasion required.

The third Memoir refers to the Indian Cycle of 60 years, called by the Hindus, the Vrihaspati Chakra. It expounds the three different ways according to which it is computed; viz. the first according to the Surriah Siddhanta, (used north of the River *Nermada*)—the second on the precepts of the Jyautistava, a book on Astrology, used in some of the Northern Provinces of Bengal, but little known in Southern India—and the third being the Cycles used by the Tellingas, which merely consists of 60 solar years.

In the three above mentioned Memoirs the Author takes as *data* all that has appeared in Mr. Davis' two Tracts on the Astronomical computations of the Hindus in the second and third volumes of the Asiatic Researches. On the contrary, what appears new to him (though perhaps not so to certain scientific readers) he will endeavour to explain to the best of his abilities.

The fourth Memoir expounds the construction of the Mahomedan Lunar year, and furnishes a General Table (inserted after the Solar and Luni-solar Chronological Tables) shewing the commencement of every year of the Hejira, from the origin of the æra to the Lunar year corresponding with A. D. 1900; according to the Julian Kalendar, as low down as the year 1582; and from thence according to both, down to the end of the Table.

The Appendix contains several Tracts, the first of which exhibits Tables for computing the Solar and Luni-solar Aharganas from an assumed epoch to any proposed instant of time, without having recourse to the rules of the Sastras. The second contains a particular method for expounding dates found on old inscriptions, the only vestiges of which may be either the *name* (or numeral) of the year according to some of the Hindu Styles, or the Sun's apparent place in the Hindu Sydereal Zodiac, at the time of the commemorated event. The third gives a short Chronological Tract, written for the purpose of facilitating the reduction of any date proposed according to Hindu Solar time, to the dates of the principal ancient and modern æras; and the fourth a specimen of the Hindu Kalendars and Ephemerides. Next follow four Fragments containing matter which may interest all sorts of Astronomers; after which the work concludes with a Glossary of the Sanscrit Astronomical terms contained in the text, of which it is also an Index.

The Author owes, perhaps, some apology for having extended in several instances, his speculations to very remote periods, both in past and future ages; the necessity, or even utility of which, are at first sight not very apparent. But those who are at all acquainted with any system of Astronomy, and particularly with that of the Hindus, need only be reminded that it would have been impos-

sible to attempt any construction or analysis depending thereon, without subjecting both to the test of time, in the revolution of ages, and what might appear to the uninformed a mere affectation of research and accuracy, will be judged by the former to arise out of the peculiar structure of a system of Astronomy, the correctness of which rests on the immense scope of its cycles and the vast intervals of its epochs.

This last consideration will indicate the quantum of labour which the present research has occasioned; for if it be considered that altho' most Hindu formulæ are very simple, even for the solution of the higher problems, yet the immense dimensions of certain quantities, expressed in natural numbers, and amounting in some cases to thirteen places of figures, renders for handling them, the use of Logarithms totally unavailable, and the European as well as the Hindu computers are compelled, in most cases, to remain satisfied with that perpetual and unwieldy instrument of Hindu Astronomy, the *Tritasica* (or rule of three) for expounding the minutest as well as the most comprehensive quantities.

It has been objected by some Gentlemen who have read these Memoirs in manuscript, that the Author has entered more deeply into the theories of Hindu Astronomy than was necessary in a work which referred principally to Chronology; but to this observation he may be permitted to answer, that for any Kalendar like those now used in Europe, where it was agreed to give to the months an arbitrary, but permanent duration, and to equate the years by certain periodical intercalations, the recurrence of which was clearly determined, there was no difficulty in devising a perpetual Kalendar for enabling any person tolerably well informed, to convert any date proposed in one style into another, without the assistance of theory.

But the case is quite different when referred to any sort of Hindu Kalendar, where there are hardly any instances of an arbitrary distribution of time, for excepting some occasional *Cshepas* (a constant number added or subtracted in certain computations to make the time fit a particular epoch) and some complementary fractions of days added to the beginning of certain Solar years,

in order to complete the time due to a given number of mean Solar revolutions, the course of the Asters remains as uninterrupted in the Kalendar as it is in their orbit.

As the singular form of the Indian *Patras* (or Kalendar) may be a matter of curiosity to Europeans, the Author has translated and inserted at the end of the volume, the first page of the *Ravi* and *Chandra Panchangum* (Solar and Luni-solar Kalendar) for the year of the Cahyng 4926, coinciding with A. D. 1824, and containing the first month of the respective years, with their usual astrological appendage, both being unlike those of any other nation, ancient or modern.

The Solar Kalendar is computed in Solar, and the Luni-solar in Sydereal time, and with different elements, which accounts for the difference of epochs assigned in each to the same phenomena (amounting sometimes to 8 hours and 58 minutes in *plus* or *minus* of European time), a circumstance which so operates, that the New Moon which is predicted in the one for a particular day, is, on the same spot, and computed perhaps by the same Astronomer, often registered for the next, in the other; a remark not to be neglected by Chronologists when they attempt to fix an epoch with precision by means of old Hindu Kalendar.

The Author readily admits that there must be many faults in the present production, some of which may perhaps not be deemed altogether excusable by those who are versed in Hindu Astronomy. Of the little merit it may possess it is not for him to speak, but he may aver, without offending truth or modesty, that he has neglected no pains to render it deserving of the patronage it has received, trusting that all liberal and candid readers will remember that in such matters,

“Optimus ille est qui minimis urgetur.”

Before closing this introduction, the Author, in justice to the memory of the late Mr. Ellis, feels bound to record in this place, his acknowledgments of the personal assistance which he received from that Gentleman during the beginning of the present research, and the patronage of the Board, of which he was

the senior Member, which brought originally the work to the notice of Government. He stands under a similar obligation to Mr. Oliver and Mr. Richard Clarke, Mr. Ellis' successors in the superintendence of the College of Fort St. George.

His thanks are also due to Mr. Hyne of the H. C.'s Medical Service, (a Gentleman well qualified for the task) for his trouble in perusing and commenting the original manuscript, before it was ordered to be printed: and to R. Audy Shashya Brahmini, the Native Astronomer attached to the College, for his professional assistance during nearly two years that he communicated with him on the subject of these Memoirs.

Lastly, the Author embraces this opportunity for paying a last tribute of respect and gratitude to the memory of the late Mr. Andrew Scott, of the H. C.'s Civil Service, for many valuable and important communications in a science which in past times, he cultivated with success, and without whose assistance several of the papers contained in this collection could never have been completed.

MADRAS, 1st March, 1825.





Those who only look in this Book for that sort of information which requires no labour, and is to be obtained by mere inspection, are referred to the Indian Chronological Tables inserted at the end of the Volume.

The Errata will be found after the Glossary.

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FIRST MEMOIR.



A KEY TO THE MADHYAMA SAURA MANA

OR

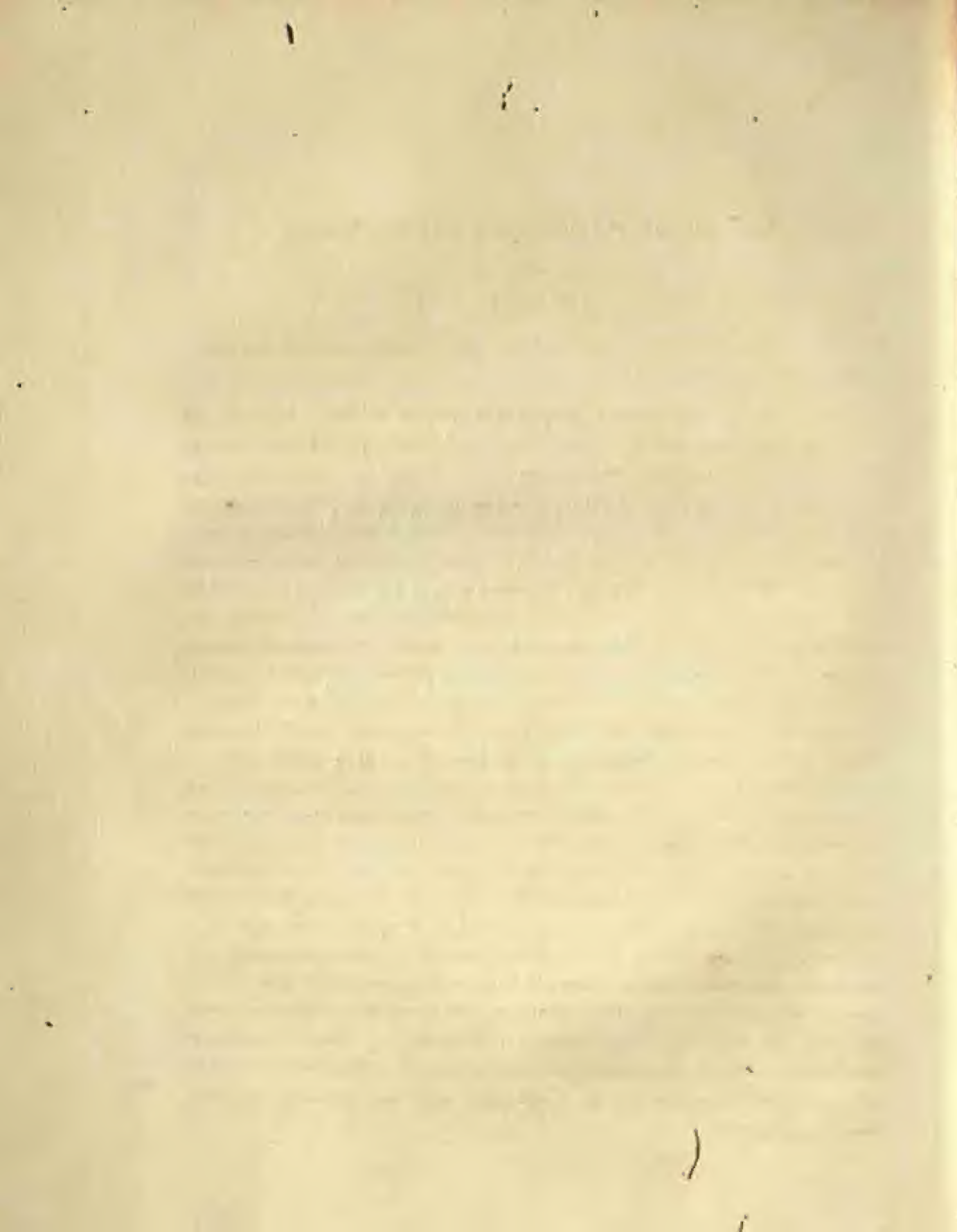
MEAN SOLAR SYDEREAL YEAR,

USED BY THE

TAMUL INHABITANTS OF THE PENINSULA OF INDIA.



Written in the year 1814; Revised and augmented in 1824.



A

KEY TO THE MADHYAMA SAURA MANA.

PART I.

General account of the Solar Sydereal and Civil years, as used by the Tamul inhabitants of the Peninsula of India.

IN most of the tracts that have hitherto been published on Hindu Astronomy, or Chronology, it has been assumed that the reader was sufficiently well acquainted with the elements of these sciences not to require a second initiation; a very mistaken idea, whether it be propagated in Europe or in India, and which, for obvious reasons, I shall not adopt on entering into the subject of this Memoir. How to open the elementary part of it without alarming the reader by a long series of definitions expressed in a dead oriental language, or how to reduce the preliminary notions which these definitions are meant to convey, to a convenient scope, without risking to become unintelligible, is an alternative which leaves only a choice of difficulties. On mature consideration, however, I have thought it advisable to follow a middle course, and shall consequently present definitions to his attention only as they become necessary in the progress of these Memoirs, unless they be of a nature very general, and easily understood. What my expositions may lose by such an option from want of scientific arrangement will, I hope, be balanced by the advantage of this research being introduced under a less discouraging aspect.

This first Memoir contains very little theory. The construction of the Solar year, such as it is generally used in that part of India which lies South of the river *Narmadā* (believed to be the same as the *Nerbudda*), is extremely simple when compared to that of the *Luni-solar* year. The perusal of it, therefore, requires little or no mathematical knowledge; but it forms, nevertheless, an indispensable introduction to the latter; and in order to render this part as efficient for that purpose as possible, a great portion of the following pages will be occupied by the exposition of certain mechanical rules, whereby the various circumstances of the common Hindu Solar year, may be easily discovered. The time consumed in becoming acquainted with these, will be recovered with profit, when in the second Memoir, we come to treat of the Astronomical year of the Hindus, the whole construction of which rests on principles so different from those of European Astronomy, that all elementary notions of that science must be laid aside for a time by the reader, if he be desirous to avoid the inconveniences which must necessarily result from premature conclusions.

SECTION I.

Of the division of Time into years, seasons, months, days, and fractions of the same; principally according to the Tamul Kalendar.

ARTICLE I.

The Tamul Solar year (as it is improperly called in the Carnatic) is Syderal, it contains that space of time during which the Sun departing from a Star, returns to the same.

Beginning of the Solar year referred to the beginning of the Lunar Zodiac by the ancients, and to that of the Solar Zodiac by the moderns.

Ancient Astronomers (by which distinction I mean those who rejected all computations made in Solar time) accounted it to begin when the Sun enters the Lunar mansion *Aswini*, the first of the twenty-seven regular *Nakshatras* contained in the fixed Lunar Zodiac (*). But modern Astronomers, who regulate the year by the Sun's revolutions without any reference to those of the Moon, account the year to begin, when that luminary enters the Sign *Mesha* (the Indian Aries) of the fixed Solar Hindu Ecliptic.

Civil and Syderal account.

Each Solar month contains as many days and parts of days as the Sun stays in each Sign. The Civil differs from the Astronomical account only from its rejecting fractions of days, each year and month being accounted to begin at Sun-rise, instead of the time of his mean entrance into the respective Signs; observing that if the said fraction exceeds 30 Indian hours (24 European minutes *ton danda* or *guddia* being the term for an Indian hour) which lapse of time is conceived to be the mean half of the day, then the Civil year, or month, are accounted to begin one day later than the Astronomical ones; whereas if the time falls below that quantity, both coincide.

The seasons.

The Hindus divide the Solar year into six seasons (called *Ritu* in Sanscrit) of two months each, the succession of which is always the same, but whose vicissitudes as to climate, depend on the place of the Sun's Apogee in the fixed Zodiac, and the position of the Equinoctial Colures relatively to the beginning of the Syderal Zodiac. Their order and names, under all possible circumstances, as well as that of the months which they comprehend, are according to the Hindu and Tamul denomination as follows. (†)

HINDU.

1 Vasanta.	2 Grishma.	3 Varsha.	4 Sarada.	5 Hemanta.	6 Sisira.
Chaitra ☾	Jyaishtva ♂	Shravana ☽	Aswina ☿	Margashirsa ♀	Magha ♀
Vaisacha ♀	Ashar ♀	Bhadra ♀	Cartiga ☿	Pausia ☿	Phalguna ☽

TAMUL.

Poongom ☾	Vyasist ♂	Audi ☽	Paratusi ☿	Cartiga ♀	Tye ♀
Chaitram ♀	Auni ♀	Auvani ♀	Arpest ☽	Margali ☿	Mausi ☽

(*) The Solar and Lunar moveable Zodiacs are called Tropical; and their position, relatively to the Syderal one, depends on the precessionary variation called *Cremi Pata-gati* in Sanscrit.

(†) It will seem extraordinary that the Tamul Astronomers should have adopted a different distribution of the months of their Solar year when referred to the seasons, from that of the other Hindus. Such, however, is the case, for according to them, the months and seasons are arranged as follows:

1 Vasanta.	2 Grishma.	3 Varsha.	4 Sarada.	5 Hemanta.	6 Sisira.
Chaitram ♀	Auni ♀	Auvani ♀	Arpest ☽	Margali ☿	Mausi ☽
Vyasist ♂	Audi ☽	Paratusi ☿	Cartiga ♀	Tye ♀	Poongom ☾

which advances the Tamul seasons by one month throughout the year.

The names of the twelve Signs of the Zodiac are

1	♈ Mesha,	2	♉ Vrishā,	3	♊ Mithuna,
4	♋ Caratā,	5	♌ Siṅha,	6	♍ Kanya,
7	♎ Tula,	8	♏ Vriśchika,	9	♐ Dhanu,
10	♑ Makara,	11	♒ Kumbhā,	12	♓ Mīna.

The signs of the Zodiac.

The twelve Signs together are called the *Rasi Chakra*, or Circle of the Signs. The Ecliptic *Cranti Mandala*, and the Equator *Nari Mandala*. Their respective Poles *Dravara*.

Names of the Ecliptic and Equator.

The names of the months used in the *Suriyah Siddhanta* are the same as those of the Signs, adding *Mara* thereto. Those of the Tamuls are

Of months Suriyah Siddhanta.

1	Chaitram,	2	Vaisāki,	3	Auni,
4	Audi,	5	Ashvini,	6	Paushā,
7	Ārṣi,	8	Cartiga,	9	Margā,
10	Tye,	11	Māusi,	12	Puṅgoni.

Tamil months.

The names of the same months used more generally by the Hindus are

1	Vaiśākhā,	2	Jaiśtva,	3	Āshar,
4	Śrāvāṇa,	5	Bhādra	6	Āswina,
7	Cartiga,	8	Māghasīra or } Agrahayana,	9	Pauṣya,
10	Magh,	11	Phālguna,	12	Chitra.

Bengal months.

The latter names are used by the *Tellings* for their Luni-solar year, with this only difference, that as the common Luni-solar year, called *Chandra Mana*, is accounted to begin with the new Moon which precedes the commencement of the Solar year, the Lunar month *Chitra* begins, and *Phalguna* ends the year.

The Hindus have a great variety of ways of considering the day, and of fixing its duration. The principal are,

The space of time called day, variously considered.

1^o The *Savan*, or natural day, is the time between two consecutive Sun risings, therefore the *Savan* days are of various duration, even under the Equator.

According to the ancient *Sastras*, or inspired books, the *Savan* day is divided into 60 *dhatas* or *ghatika*; the *dhatas* 60 *vinadikas*, the *vinadikas* 60 *pranacalas*; the *pranacalas* 10 *vipalas*.

2^o The *Saura* day is the time during which the Sun describes one degree of the Ecliptic. These days are therefore longer or shorter, as the Sun is near his Apogee or Perigee. They are divided in the same proportions as the *Savan* days but with different names, viz. *Danda*, *ricala* or *pala*, *pranacala*, (or respiration) *castacala*.

Astronomers sometime divide time in minute parts; thus the *vipala*, or *castacala* into 60

alipsalas, the alipsala into 3600 nimeshas or twinklings of the eye, on account of which this sort of time is denominated *Marta*, meaning as above.

3°. The Nacahatra day, which is also frequently called Saura, with a different meaning from that formerly mentioned.—It is Syderial, being the time between the *same point of the Ecliptic rising twice*; or rather the time between the Equinoctial points (called *Ayana*) rising twice. These days are accounted to be equal to one another throughout the year and are used by the Tamul Astronomers who compute in Solar time in their preparatory operations; being always equal to 60 guddias, subdivided sexagesimally into viguddias, paras and suras, which denominations are also used in Lunar computations. It is proper, however, to observe here, with a view to avoid future confusion, that the measure of time called guddia means also an arc or portion of a Nacahatra (or Lunar mansion) of $13^{\circ} 20'$, which is likewise subdivided into viguddias, paras, &c. having no immediate reference to time.

The fractions of the Solar day used in this Memoir are invariably the last mentioned. The Lunar day or Tidhi will be noticed more conveniently in its proper place.

The names of the days of the week are common to all styles and prevail all over India. They have the same signification as those used in ancient and modern Europe, and are as follows:

Names of the days of the week.

1	Sunday	Ravi.yara	Sun
2	Monday	Soma.yara	Moon
3	Tuesday	Mangala.yara	Mars
4	Wednesday	Bhuda.yara	Mercury
5	Thursday	Guru.yara	Jupiter
6	Friday	Sakra.yara	Venus
7	Saturday	Sani.yara	Saturn.

The unequal portion of time assigned to each month, dependant on the situation of the Sun's Apis, and the distance of the Vernal Equinox (called *Merha Ayana*) from the beginning of the sign Mesha, is also affected by the difference of time which the Tamul Astronomers assign to the Sun for moving through the Northern and Southern signs of the Ecliptic, the time for the former being 186 days, $21^h 38^m 24^s$, and for the latter 178 days, $8^h 34^m 6^s$. The odd hours and minutes of which they apply to the beginning of the year and months; and being so distributed they do not require the assistance of Leap, or Bissextile years, because they reckon the Astronomical beginning of each, from the hour and minute over 365 days when the last year and month expired.

Time of the Sun moving through the Northern and Southern signs.

The Civil Solar year of 365 and 366 days.

The Civil year, however, is of 365 and 366 days, like that of the Europeans, the latter being determined by the rejection of fractions, as was already hinted at page 4, and not by any regular intercalation. It results from this arrangement that Civil time is sometime longer, sometime

shorter than the Astronomical. Thus according to the Tamul computations the month of *Anni* of the year of the Cali yug 4817 (June 1745) commenced on Thursday at 44^h 50^m after mean Sun rise, which exceeding 30 guddias shows that it began 14^h 50^m after Sun set, and so by the Civil reckoning the first of *Anni* fell on Friday the 11th, instead of Thursday the 10th of June; and as it ended on Monday the 12th of July, it follows that the Sydercal month of *Anni* was of 32 days, and the Civil only 31. In the same manner, as the following month *Audi*, began on Monday the 12th July at 21^h 28^m 18^s (below 30 guddias) and ended on Thursday the 12th August at 49^h 40^m 20^s (above 30^s;) it follows that the Civil month was of 32 days, and the Sydercal only 31.

From these preliminaries we shall be enabled to discover by means of the fraction of the root or initial feria of the month Chaitram and Solar year (called *Santa dina*) whether it be one of 365, or 366 days according to Civil account, but we must previously show how the Tamuls compute the beginning of their years and months.

In order not to crowd unnecessarily the matter on the reader's attention, I shall assume for the present that he knows that the Hindus have imagined, among several others, four grand periods which collectively taken form one of 4320000 years, called a *Maha yug* or great period of con- junction of the Planets in the beginning of the Hindu Zodiac—that these are called the *Satya yug*, the *Treta yug*, the *Devapar yug* and the *Cali yug*; the latter of which (that in which we live) consists of 432000 years, and that of these years 4925 had expired in A. D. 1824—the current one being the 4926th (of the Cali yug). We need therefore carry our present speculations no higher than the beginning of that era, as the Tamul Astronomers are contented to do when they compute their Solar Kalendar.

The four yugs.

ARTICLE 2.

Rule for finding the mean epoch of the commencement of the Tamul Solar year.

The Tamul Astronomers have adopted the Solar year of the *Aris Siddhanta*, the duration of which is 365^d 15^h 31^m 15^s, in preference to that of the *Surriah Siddhanta* which is 365^d 15^h 31^m 24^s (*), and as they generally work in Solar time, they use it also in their Lunar computations: but this is to be understood only of the Northern Tamuls, called *Vachij* by their Southern neighbours, (I suppose on account of their using the *Vaktam* process in their operations), for the latter, who stile themselves *Sittandij*, employ another Solar year, of 365^d 15^h 31^m 30^s, and make use of a Cycle of 90 years, the construction of which will be explained in a subsequent article.

Duration of the Solar year *Vachij* 365^d 15^h 31^m 15^s.

Sittandij 365^d 15^h 31^m 30^s.

(*) According to the *Aris Siddhanta* there are 1577917300 days (called *Puga dina*) in a *Maha yug* or 4320000. Hence one year = $\frac{1577917300}{4320000} = 365^d 15^h 31^m 15^s. Indian time, 365^d 6^h 12^m 30^s. European time. According to the *Surriah Siddhanta* the *Puga dina* is 1577917328, hence the year is $\frac{1577917328}{4320000} = 365^d 15^h 31^m 24^s. Indian time, and 365^d 6^h 12^m 30^s 34^s. European time. And lastly, according to the *Sittandij*, the same expression is $\frac{1577917332}{4320000} = 365^d 15^h 31^m 30^s. Indian time, and 365^d 6^h 12^m 30^s. European time.$$$

Rule for finding the Ahargana or time elapsed from the beginning of the Cali yug to that of any proposed year.

Rule for finding the Ahargana.

"Write the numeral of the proposed year in two places; multiply the first by 365½ and the second by 5. Subtract 1237 from the product of the latter, divide the remainder by 576, the quotient will give *days*. Multiply the second remainder by 60 and divide again the product by 576, the quotient will give *guddias*, and so forth to *viguddias* and *paras*.—Add the *days*, *guddias*, &c. thus found, to the product of the numeral into 365½, so shall the sum be the *Ahargana* sought, i. e. the time expired on the day computed for, since the origin of the *Cali yug*."

For the *Soota dina* or initial feria of the year, "divide the sum of *days* above found by 7, the quotient will give the number of weeks expired, which neglect; and the remainder will be the odd day, over complete weeks, which counted from *Friday* (the day on which the week was supposed to end) will give the initial feria of the year sought."

N. B.—If after dividing the second term of the rule by 576, down to *paras*, there is no remainder, it is a proof that the operation was well performed.

EXAMPLE.

Let the year of the *Cali yug* 4847 current or 4846 complete, be proposed, wanted its *Soota dina* and time of the day on which it began.

1 ^a	2 ^a	Continued.
4846	4846	60
365½	× 5	Multiply 60
24230	24230	3600
29076	Sub.— 1237	Divide by 576
14638	22803	Quotient 6 <i>viguddias</i> ,
1765760	Div. by ÷ 576	With a remainder of 144
1211 30	Quotient 39 <i>days</i> .	Mult. by 60
1770001 30	With a remainder of 529	2640
	Mult. 60	Div. by 576
	31740	15 <i>paras</i> .
	Divide by 576	Without a remainder.
	Quotient 55 <i>guddias</i> .	
	With a remainder of 60	
3 ^a	d. c. v. r.	
Product of No. 1	1770001 30	
of No. 2	39 55 6 15	
Ahargana or Time expired	1770011 25 6 15	

7)1770041 252863 weeks,

Remainder 0, which counted from *Friday*, leaves *Friday*

Soota dina,

for the initial feria, or *Soota dina*.

ANSWER.

The year of the Cali yug 4847 began on a Friday at 25^h 6^m 15^s after Sun rise, and as the guddias do not exceed 30, the Syderal and Civil years begin on the same day.

Father Beschi, from whom I have borrowed this Rule, is silent on the Meridian to which it refers; it is therefore necessary to supply that omission.

The Hindus refer to two principal Meridians—those of *Lanca*, and of *Ramissuram*, more properly *Ram-Ishura*.

Lanca is an imaginary place supposed to lie under the Equator, somewhat S. W. of the Island of Ceylon; it is one of the four cities (*Yanacoli* being the first, *Lanca* the second, *Bornacoli* the third, and *Siddhapuri* the fourth) which are supposed to lie under the Equator at 90 degrees distance from each other.

The Indian principal Meridians:
Lanca,
Ramissuram.

The Meridian of *Lanca* is supposed to pass through two other towns on the Continent of India, namely, *Sannihita-surur*, and *Aznath*, the latter, according to common opinion, being *Ujjayini*, now called *Oogcin*, which lies in 23° 11' 30" North Latitude.

The Tamil Rule refers to the Meridian of *Lanca* a place under the Equator.

That Meridian (in Sungscrote Recta) is supposed to lie 76° 53' 15" (5^h 3^m 35^s) East of Greenwich; and 73° 33' 0" (4^h 54^m 12^s) East of Paris (*), and to this the preceding Rule refers.

Ramissuram is a small Island, situated between Ceylon and the Continent of India, at the entrance of Fulk's passage in the Streights of Munaar, and is famous for its ancient Pagoda and Observatory.

It lies in 70° 22' 5" (5^h 17^m 28^s 30") Long. E. of Greenwich,

and 77° 1' 50" (5^h 8^m 7^s 30") East of Paris.

Its Latitude is 9° 18' 7" North.

N. B.—This position was extracted from Colonel Lambton's Trigonometrical Survey. (†)

Demonstration of the Tamil Rule for finding the Ahargana, and initial feria of the year, called Soota dina.

The first part of this operation, which goes to multiply the numeral of the proposed year of the Cali yug by 365 $\frac{1}{4}$, requires no demonstration; that multiplier including the 15 odd guddias (6 hours) over the number of entire days contained in the year, which, as was before stated, consists of 365^d 13^h 31^m 15^s (365^d 6^h 12^m 30^s Eur. time). But we are to account for the remaining 31^m 15^s (12^m 30^s Eur. time) by which the years of the Caliyug expired ought also to be multiplied.

Demonstration of the Rule.

Now, adverting to the process as disclosed at page 8, for the reason that the sum of years is

(*) *Lanca* may be supposed to lie very nearly South of Calicut, the Meridian of the latter place passing only 64. 4m. 15s. West of the Recta of *Lanca*.

(†) The Rules and Tables of Mulli-Carjanada, and Ralla-Itty Cello, refer to the Meridian of *Ramissuram*.

multiplied by 5, it follows that you are to take only the 1.5th part of 31* 15p or 1875p, that is $12\frac{3}{4}p = 575p$, or what is the same thing $6\frac{1}{4}$ viguddias.

Now to multiply successively the complete years of the Cali yug 4846 in terms of days, &c. we are to consider that $6\frac{1}{4}$ may be converted into this expression $\frac{2575}{32}$, the numerator expressing the number of minutes in a Tamil hour or *guddia*; and as the Rule goes to divide the product of the elapsed years multiplied into 5 by 576, we have $4846 \times 5 \times \frac{2575}{32} = 1846 \times 31\frac{1}{4} = \frac{2575}{32} \times 60 \times 60 \times 60$ in which expression the first factor gives the product in days, the second in *guddias*, the third in *viguddias*, and the fourth into *paras*.

We are now to enquire why, having multiplied the years of the Cali yug expired by 5, we have subtracted 1237 from the product.

Observe that, if that number be divided as before by 576 it will give 2d 8g 51* 15p, therefore, seeing that according to Hindu account the first year of the Cali yug began on the 4th day of the week at 51g 8* 45p, and that if 1237 be divided by 576 the quotient will give

p.	g.	v.	p.
2	8	51	15
4	51	8	45

we have a complete week

p.	g.	v.	p.
7	0	0	0

so that this equation is merely contrived for the sake of counting the days in the *Ahargana* from a complete period, i. e. the beginning of the week as it was then considered to be, and this addition will be equally performed, whether you add it to the year, or subtract it from the epoch, in which latter case however, it will be made to begin 2d 8g 51* 15p sooner than it ought, increasing the *Ahargana* by thus much, which is the cause of the subtractive equation when that element is computed by the Tables.

Having operated agreeably to the preceding Rules, you are to reckon from *Friday*, because it was then taken to begin the week.

But if you wish to reckon from *Sunday*, you are to subtract two days from the above account, which will be done if you retrench twice 576, or 1152, and if instead of 1237 you subtract 2389. The latter is the practice of the Southern inhabitants of the Peninsula, called *Sittandij*.

The Rule and Example given at page 8, as it includes the subtractive quantity 1237, is therefore to be expressed as follows:

$$\frac{4846 \times 5 - 1237}{576} \times 60 = \frac{2575}{32} = 39 \text{ } 55 \text{ } 6 \text{ } 15$$

and this added to $4846 \times 365 = 1770001 \text{ } 30 \text{ } 0 \text{ } 0$
as before found $\quad \quad \quad 1770041 \text{ } 25 \text{ } 6 \text{ } 15$

and we are to reckon from *Friday*. But if you wish to reckon from *Sunday*, it will be

$$\frac{4846 \times 5 - 2389}{576} \times 60 = \frac{2131}{32} = 37 \text{ } 55 \text{ } 6 \text{ } 15 \text{p.}$$

N. B.—It frequently occurs, in the course of research, that it is expedient to compare the *Ahargana* elicited by the Rule, with that which may be procured by means of the Tables. It is therefore necessary to warn the reader, that although the *Ahargana* used by the Northern Tamil Astronomers is constructed so as to reckon from *Friday*, yet if we seek the initial *feria* of the year, for the same account, by means of Table I. (page 1 of the Tables), we are to count the root of the days inserted between parenthesis, from *Sunday*, which is not the case when using Table XLVIII page 66, where the remainder after division by 7 is to be told off from *Friday*.

ARTICLE 3.

On the manner of computing the beginning and duration of the twelve months of the year.

In the present position of the Sun's Apis (*Ravi-Mandocha*) which only moves at the rate of $1''$ in 517 years, and which at the end of the year of the Cali yug 4846 (*) (A. D. 1745) was in $2^{\circ} 17' 10'' \cdot 4$ from the first point of the Hindu Zodiac—and of the distance of the said point from the Equinoctial ecliptic (*Ayanansa*) which increases $54'$ in a year, and was at the end of the same year equal to an arc of $18^{\circ} 41' 23'' \cdot 11''$, the separate duration of each of the twelve months of the Solar year (in the aggregate always equal to $365^{\circ} 15' 31'' \cdot 15''$) was as follows:

BENGAL.			TAMIL.			BENGAL.			TAMIL.		
	Solar Months.		Solar Months.		Duration.		Solar Months.		Solar Months.		Duration.
1	Vaisacha	Chaitram	30	55	32 1	7	Cartiga	Arpasi	29	54	7 1
2	Jath'ta	Vaissei	31	24	12 1	8	Margasirar	Cartiga	29	50	24 2
3	Ashar.	Auni	31	36	38 1	9	Paushya	Margali	29	20	53 1
4	Shravana	Audi	31	28	12 2	10	Magh	Tye	29	27	15 1
5	Bha'dra	Aurani	31	2	10 1	11	Phalguna	Maasi	29	48	24 1
6	Aswina	Parvasi	30	27	22 1	12	Chitra	Pongent	30	20	21 2

Now if it be required to find the *Ahargana*, and initial *feria* (*Soota dina*) in the beginning of each Solar month of the current year of the Cali yug 4847, having found the same for the beginning of the year by the general rule given at page 8 (or by means of Table I), all that need be done is to add successively thereto the *abstract* duration of each month, as above exhibited, and dividing as usual by 7, the remainder counted from *Friday* (or if the Table be used the Root between parenthesis from *Sunday*) will give the *Soota dina* sought.

How to compute the beginning and duration of the months.

The following example will answer for all possible cases, when computing in *Consequentia*. The quantities for each month must of course be subtracted when working in *Ante-dentia*.

(*) 9th April N. S.

EXAMPLE.

	By the Rule.					By the Tables.			
	D.	S.	V.	P.		D.	S.	V.	P.
Ahargana for the beginning of A. C. 4847	1770041	25	6	15	Initial Root of A. C. 4847	(5)	25	6	15
Abstract dur. of Chaitram	30	55	32	1	Table III.	(2)	55	32	1
Ahargana 1st Vissai of Vissai	1770072	20	38	16	Monday	(1)	20	38	16
	31	24	12	1		(3)	24	12	1
Ahargana 1st Anni of Anni	1770103	44	50	17	Thursday	(4)	44	50	17
	31	36	38	1		(3)	36	38	1
Ahargana 1st Audi of Audi	1770135	21	28	18	Monday	(1)	21	28	18
	31	28	12	2		(5)	28	12	2
Ahargana 1st Anvari of Anvari	1770166	49	40	20	Thursday	(4)	49	40	20
	31	2	10	1		(3)	2	10	1
Ahargana 1st Paratasi	1770197	51	50	21	Sunday	(0)	51	50	21
	&c.					&c.			

Here the process by the Table indicates at once *Sunday*; but if we had worked merely by the Rule for the 1st of *Paratasi*, it would be 71770197.252883 weeks with a remainder of 2 which counted from *Friday*, gives equally *Sunday*.

ARTICLE 4.

On the Civil years of 365 and 366 days.

Before entering into the manner of expounding the initial feria of the Hindu Solar months for the European concurring date, we shall consider the effects of the operation of the fraction of days annexed to the number of *entire* days for each month, already hinted at page 4.

Year of 366 Civil days how discover- ed.

The number of registered days contained in any Solar month depends on the value of the fraction of the first *Ahargana* in the year, which is variable. This fraction combined with those of the remaining months (which abstractedly are constant) determines the character of the year, by which is meant whether the *Civil* is one of 365, or 366 days: because when the sum, or difference, for any month exceeds 59g 59v 59p, its initial feria passes suddenly from one day to its next.

Thus if the beginning of Chaitram and Solar year be expressed by the Root

And if you add thereto the collective Roots up to the month *Tye v7* (Table III)

You have the *Soota dina* for *Maasi* =

Tuesday, which if expounded in the European Calendar with the Dominical Letter F, as shall be shown hereafter, will elicit *Tuesday* the 19th February *Syderaal* account.

But if the same Root	-	-	D.	S.	V.	P.
be only encreased by	-	-	(5)	53	13	47
			-	-	+	1
and you add for <i>Tye</i> as before	-	-	(5)	53	13	48
you have the beginning of <i>Maasi</i>	-	-	(4)	0	46	12
			(3)	0	0	0

on Wednesday the 12th February; and so the month *Tye* which had before only 22 Kalendar days, would in the latter case count 30, and the following month *Poongoni* ४, which had 30 days before, would now only count 29.

This circumstance, which generally operates so as to exchange the value of two near months, so that their sum remains the same, yet sometimes produces a different result, and determines a Leap or a common year.

Thus let the Root for the beginning of Chaitram and year be - Wednesday (3) 50 59 59
 And suppose that being expounded with the Dominical Letter G it brings out the
 11th of April, add one pair thereto - - - - - + 1
 Thursday (4) 0 0 0

then you have *Thursday* the 12th April, and the Civil month Chaitram, which in the former case counted only 31 days, will now only count 30, without an equivalent in the next month.

But it will be further shown that, whenever the Root for Chaitram and year exceeds 44g 28v 44p the proposed year invariably counts 366 days; therefore in the present case, the said year would become a common instead of a Leap year, which it would have been.

Generally the European date concurrent with the beginning of Chaitram and year is an Index which points out whether the Hindu Solar year propounded, consists of 365 or 366 days in the Kalendar, which (to use common language) I shall in future call *Common* and *Bisextile*, altho' the latter do not recur by arbitrary intercalations, as is the case in the European Kalendar.

The same date also indicates the limits of the beginnings of the 11 remaining months of the same year, when referred to our Kalendar, in a manner that cannot be mistaken, notwithstanding the great variety of combinations of which the Roots are susceptible.

RULE.

1^o "Whenever the fractional part of the Root which elicits the beginning of the year falls below 44g 28v 44p, or up to it, then the year counts only 365 days in the Kalendar."

2^o "And when the fraction amounts to 44g 29v 45p then that Civil year counts 366 days."

The demonstration of this precept flows from what has already been said: for
 let the fraction of the initial feria proposed be - - - - - 44 28 45
 Add the fraction of the Root for one year complete - - - - - 15 31 15

You have for the sum - - - - - 12 0 0 0

that is, one entire day over and above the sum of days independently of the fractions.

EXAMPLE I.

On the beginning of the year of the Cali yug 4856 (A. D. 1754), the initial Root n. a. v. p. is found to be - - - - - Tuesday (2) 44 47 30
 which if expounded with its Dominical Letter F, will give 9th April N. S.

Now if you add thereto the Root for one complete year (Table I) - - - - - (1) 15 31 15

You have beginning of - - - - - Thursday (4) 0 18 45

the year of the Cali yug 4857:

When the Root of Chaitram exceeds 44g 28v 44p the year is of 366 days.

Root for the beginning of Chaitram and year expounded into European time — an Index which shows whether the year consists of 365 or 366 days, and indicates the limits of the other 11 months.

How to discover a common year.

A Bisextile year.

which Thursday being expounded with its proper Dominical Letter E, falls on the 10th April 1755, and shows that the year of the Cali yug 4835 (or Saca 1677) counts 355 days in the Kalendar.

EXAMPLE II.

But if the year of the Cali yug 4882 (A. D. 1781), the proper Root of which is Monday (1) 43 51 15 be proposed, and this Monday be expounded with the proper Dominical Letter G, it will fall on the 9th April N. S.

Add as before the Root for one year - - - - - (1) 15 31 15

And you have the beginning of - - - - - Tuesday (2) 59 22 30

the year of the Cali yug 4884. Now the said initial feria being expounded with the proper Dominical Letter F, falls also on the 9th of April N. S. (A. D. 1782), and the corresponding Christian year being a common one, the Tamil Solar year is one of 355 days.

Having calculated by these Rules the Tamil Leap years of 355 days concurring with the Christian year of the XIXth Century, they were found to fall as follows :

Number of Leap years.	Christian Years.	Leap Years of the Cali yug concurring with do.	Years from the birth of Salivaha. na.	Number of Leap years.	Christian Years.	Leap Years of the Cali yug concurring with do.	Years from the birth of Salivaha. na.
1	1801. 2	4903	1724	14	1851.52	4953	1774
2	1805. 6	4907	1728	15	1855.56	4957	1778
3	1809.10	4911	1732	16	1859.60	4961	1782
4	1812.13	4914	1735	17	1863.64	4965	1786
5	1816.17	4918	1739	18	1867.68	4969	1790
6	1820.21	4922	1743	19	1870.71	4972	1793
7	1824.25	4925	1747	20	1874.75	4976	1797
8	1828.29	4930	1751	21	1878.79	4980	1801
9	1832.33	4934	1755	22	1882.83	4984	1805
10	1836.37	4938	1759	23	1886.87	4988	1809
11	1840.41	4942	1763	24	1890.91	4992	1813
12	1843.44	4945	1766	25	1894.95	4996	1817
13	1847.48	4949	1770	26	1898.99	5000	1821

Thus there happen to be 26 Leap years in the XIXth Century, instead of 25 as is the case in the Julian, and 24 in the Gregorian Kalendar (when the latter does not begin with a Bissextile year, as A. D. 1600, 2000, &c.) which will serve to explain hereafter, why the Julian Kalendar recedes, by one day, and the Gregorian two days, from the Tamil Secular years.

ARTICLE 5.

On the limits of the number of Civil days contained in the eleven last months of the year.

With respect to the beginning of the eleven last months of the year, and the manner of deter-

The limits of the beginning of the 11 last months how determined.

mining the number of civil days contained in each in any particular year, the initial root of the year affords likewise an Index from which the beginning of the eleven last months never recede (in their proper concurrent European month) more than *two days*—and never exceed beyond *four* : and furthermore shows, that in the present positions of the Sun's Apis, and Equinactial Colure, the Tamul month *Mausi* \equiv (Indian February) is alone, and invariably that which anticipates the European date of the beginning of Chaitram in the New Style. (*)

Thus if the 1st Chaitram and year of the Cali yug 4847 be found to fall on the 9th April 1745 N. S. the beginning of the month of *Mausi* will fall on the 8th February 1746—and if the 1st Chaitram and year of the Cali yug 4918 falls on the 10th April 1816 N. S. the 1st of its month *Mausi* will fall on the 9th February 1817 ; and no other month in the year will be subject to the same subtraction.

The limits of *Mausi* are constant in the Gregorian year, always —.

This consideration reduces the limits of the other ten months (in their concurrent European months) to the compass of four days, to be added to the date of Chaitram in its proper European month.

Those of the other 10 months always —.

Thus if the 1st Chaitram of the year of the Cali yug 4918 falls on the 11th April 1813 N. S. none of the other months in the same year will begin later than the 15th of its own concurring European month, or earlier than the 11th.

These limits being less than a complete week, never leave the least doubt, when converting Tamul into European dates, into which of the four weeks and fraction of week the initial feria of any Tamul month elicited by the Rule, should fall according to European account.

With respect to the Syderal and Civil duration of the Tamul months of any proposed year, it is manifest that since the initial feria of each month may be elicited by the Rule or the Tables, and since we possess the limits within which these must fall, any European Kalendar, or series of Dominical Letters, will suffice for determining the length of the proposed month.

How to determine the Civil and Syderal duration of each Tamul month of any proposed year.

Thus let it be proposed to find the Syderal and Civil duration of the Tamul month *Auni* of the year of the Cali yug 4858 (A. D. 1754-5). Having computed the initial feria and fraction for that month according to the preceding Rules, which are (vide Table D. C. V. 2. X, page 13) Tuesday (2) 4 31 32
and that for the following month *Audi* Friday (5) 41 9 33
and the Dominical Letter for A. D. 1754 N. S. being F (+), if we take Tuesday (A) to be the

(*) In the Old Style *Mausi* falls always one day and *Poonengi* two days (in their respective European concurring months) behind the date of Chaitram, in its own European month ; but the extreme limits confine to be five days, because the other ten months cannot exceed the European date of Chaitram in their proper concurrent month, more than three days.

(†) Any Dominical Letter assumed at pleasure will answer the same purpose for the abstract duration of the month without any reference to the European Kalendar.

1st of Auni, and count down to the Friday (D) which falls between 23 and 32 days, we find that it corresponds to the 32d day, *Tuesday* counted as one, which marks the first day of the Tamul month *Audi*, and consequently that *Auni* (the month for which the computation is made) contains 31 days.

Now the fraction of time annexed to the initial feria of *Auni* is 4x 31+ 32p which being below 30 guddias (page 4), shows that the month began at *day time*, and therefore the Sydercal and Civil beginning coincide.

But the fraction of the initial feria of *Audi* is 41x 0+ 33p, which shows that the month began at *night time*, therefore the *Civil* month commenced not on *Friday*, but on *Saturday* following, the Civil and Sydercal account differing by one day—therefore the Sydercal month *Auni* is of 31 days and the Civil of 32.

This method is so plain, that although the proposition presents three feasible cases, viz. 1^o When the Roots are both below or above 30x, when the Civil and Sydercal months are of the same duration. 2^o When the Root of the first is below, and that of the second above 30x, in which case the Civil is greater than the Sydercal; and 3^o When the first is above, and the last is below 30x, in which case the Civil is shorter than the Sydercal month, yet the process being always the same, hardly requires any further illustration. For it is plain that if we wish to refer the same to the European Kalendars, provided the Christian date of the initial feria of the year, and the Dominical Letters according to either Old or New Style be given, then the date of beginning and duration of the twelve months of the Tamul years may always be known by their Roots without difficulty.

Thus if the initial root of the year of the Call yug 4856 be *Tuesday* (2^d) 41x 47+ 30p—the Dominical Letter for A. D. 1754 *Old Style* be B; and the date of the above Tuesday 29th of March, the Root for the beginning of *Viassei* being *Friday* (5^d) 40x 19+ 31p, if we proceed as shown before, it will be found to fall on the 29th April, and (counting Tuesday as one) the Tamul month *Chaitram* will consist of 31 days *Sydercal* and *Civil* account.

And if the same be computed for the New Style, the Dominical Letter for 1754 being F, then, if *Tuesday* 1st *Chaitram* is said to fall on the 9th April N. S. *Friday*, the initial feria of *Viassei* will fall on the 10th May, and the first Tamul month will consist of 31 days.

Lastly, it is to be remembered when reckoning according to Civil account, that if the Civil month begins one day later than the Sydercal, it displaces *by one*, every succeeding day in the same month, and this until the Sun, by entering a new Sign, determines the future coincidence or dissidence of the Civil and Sydercal dates of the ensuing month.

What we have hitherto stated on the general construction of the Solar Sydercal year, will be frequently referred to in the course of this work, when it comes to treat of the resolution of the

Astronomical Lunisolar year by means of the *Vakiam* process, and Tables, such as it is used by the modern Tamul Astronomers; differing in this respect from the Telingas, who still adhere rigidly to the doctrines of the Suriah Siddhanta.

The Tamul Kalendar is in itself as simple as the European, but as its columns record true time for the particular place where it is intended to be used, and as its margin is loaded with a variety of articles foreign to its immediate purpose, which require a greater knowledge of Hindu Astronomy, than the reader is at present supposed to possess, it is indispensable, in order to render that acquirement practically useful, to furnish him with the means of converting dates proposed according to the Hindu Solar account, as explained in the preceding pages, into corresponding European dates and vice versa, and to that object we shall devote the remaining part of this Section.

Should, however, the reader be desirous to inspect a specimen of the Ravi-Panchangum, or Solar Kalendar as it is published in the Southern parts of the Peninsula of India, he will find a translation of that part of it which refers to the first month of the year of Cali yug 4923 (A. D. 1825), inserted at the end of all the Tables; for we have already occasion for a greater number of technical terms in the present Memoir than is convenient, without adding to these a number of Astrological definitions, which cannot be dispensed with for understanding the *Addenda* of the Ravi Panchangum.

ARTICLE 6.

The manner of numbering the Indian years of the Cali yug, when referred to European accounts.

The number of years expired since the beginning of the Cali yug on the birth of Christ, *Dyonisian* account, are 3101; therefore, the current year A. D. 1 corresponds to part of the 3102d year of the Cali yug.

It will save a great deal of future embarrassment to the reader if he notices particularly at this place, that according to established usage, the years of *all the Hindu Styles* are said to concur with that Christian year *during which the last expired ends*. Thus if the years of the *Cali yug*, or *Saka*, which correspond to A. D. 1822 be asked of any Indian, he will call it 4923 *complete*, because that Solar year ends on the 11th April N. S. of the said Christian year. But as the current Indian year 4924 begins on that day, and continues until the 11th April 1823, it might otherwise be more properly coupled with the latter.—It is therefore a general rule, when any year of the Cali yug is to be deduced from the numeral of the European year to which it corresponds, that *unity* be subtracted from the latter before adding the epoch thereto; which is the practice followed by *Father Barchi*, and that which is used in the Examples given at the end of this Memoir.

Of the era Cali
yugem.

1822
3101
—
4923

For the numeral of
the year of the Cali
yug, unity to be re-
tracted from the
European year be-
fore adding the
epoch 3102.
1821
3102
—
4923

ARTICLE 7.

*Of the æra Salivahana.**Æra Salivahana.*

The beginning of the æra Salivahana dates from the birth of a Prince of that name whose history is connected with Hindu Mythology: that event is supposed to have taken place when 3179 years of the Cali yug had expired, which makes it fall 78 years after the birth of Christ.

The years when reckoned according to that account are called *Saca*, but differ in nothing from the common Solar year, the elements of which were disclosed in the preceding pages. It is customary in these Provinces, (and I believe in all parts of India) when dating any document, to couple the numeral of the year *Saca* with that of the Cali yug. Thus if the current year be asked of any Native, he seldom fails (besides other distinctions) to say, for instance "The year 4782 of the Cali yug, or *Saca* 1603."

Modern Astronomers make frequent use of this æra for abridging certain Astronomical computations, as will be seen hereafter in the article which treats of the Cycle of 60 years.

The current year *Saca* may always be determined by the following

RULE.

For the numeral of the year Sacæ.

Let the year of the Cali yug complete be proposed	-	-	-	-	4846
	-	-	-	-	subtract 3179
Year <i>Saca</i> complete	-	-	-	-	1667
Let Anno Domini current be proposed	-	-	-	-	1745
	-	-	-	-	subtract 78
Year <i>Saca</i> complete	-	-	-	-	1667

Or if you wish to have the three successively by one operation for A. D. 1745 current, say first $1745 - 1 = 1744$

Add the year of the Cali yug expired	-	-	-	-	1744
	-	-	-	-	3102
At the birth of Christ, you have A. Cali yug	-	-	-	-	4846 complete
Subtract epoch of Salivahana	-	-	-	-	3179
You have the year <i>Saca</i> sought	-	-	-	-	1667 complete

and let it be remembered that the Christian year proposed concurs partly with the years of the Cali yug 4846 and 4847, and *Saca* 1667 and 1668, in the same manner that the first of each of these years corresponds partly with A. D. 1745 and 1746.

ARTICLE 8.

*Of the æra Vicramaditya.**Of the æra Vicramaditya.*

There is another æra called *Vicramaditya*, little used in the Southern parts of India. It numbers the Lank-solar years, in the same manner as that of *Salivahana* does the Solar ones.

Vicramaditya is said to have been a Prince who reigned 135 years before *Salivahana*, and supposed to be one of his ancestors. Its epoch begins when 3044 years of the Caliyug were expired, i. e. 57 years before Christ; so that if any year of the Cali yug be proposed, and the last expired year *Vicramaditya* be wanted, which let it be A. Cali yug 4925, subtract 3044

therefrom, you have 1881, the year sought. Or if the Christian year be proposed, which let be 1824; add 57, and you have 1881 as before.

ARTICLE 2.

Practical manner of determining the commencement of the Solar year.

In order to discuss what may be farther stated on the mode of determining the beginning of the Solar year, I shall observe, independently of all computations, that there are several ways of fixing the same practically. These consist in observing the passage over the Meridian of some *yaga*, or Zodiacal Star (the principal one of each Lunar mansion) the position of which is given in the Hindu Tables.

Thus *Hershana*, the *yaga* of, and only Star in the Lunar mansion *Chitra*, is accounted by the Hindu Astronomers to be exactly six Signs in Longitude from the beginning of the Solar Zodiac. European Astronomers take this Star to be *Spica Virginis*; so that when it is observed to pass over the Meridian at midnight any where, the mean Solar year ought to begin: altho' modern Astronomers account its Civil commencement to be on the ensuing Sun rising.—Whether the original position of the Star in Right Ascension and Declination from which the Hindu Astronomers have deduced its Longitude, have been wrongly determined, as is most probable, or that they advert to another Star, our determination of the first point in the Indian sign *Aries* by *Spica Virginis*, gives a material difference in the results.

I have computed its Longitude for the year of the Cali yug 3600 complete, answering to 18th March A. D. 499, when it is supposed there was no *Ayanansa*, and also for A. C. 4911 complete, when the *Ayanansa* was 19° 39' 54" using De Lalande's Tables, and the difference at the respective epochs were

Longitude <i>Spica Virginis</i> 20th March 499	-	-	-	-	6° 2' 47' 50" 53"
By the <i>Ayanansa</i> for Solar year Cali yug 3600 complete	-	-	-	-	6 0 0 0 0
				Difference	2 47 50 53
Longitude of <i>Spica Virginis</i> 20th March 1810 <i>Julian Style</i>	-	-	-	-	6 21 11 32 55
By the <i>Ayanansa</i> for the year of the Cali yug 4911 complete	-	-	-	-	6 19 39 54 2
				Difference	1 31 38 55

By which quantities the *yaga Hershana* exceeded at the respective epochs the Longitude ascribed to it, a circumstance which would have retarded the beginning of the Solar year of the Cali yug 3601 by 2d 29h 7'—and that of 4912 by 1d 13h 11' 30".

Independently of *Hershana*, the *yaga* of the Lunar mansion *Revati*, supposed to be the same as ζ Piscium, and called by the Hindus *Vaidhrity*, is taken by them to be in the last point of the sign *Min*, the Indian *Pices*; or what comes to the same in the first of *Mesha* (*Aries*), so that

Practical determination of the beginning of the Solar year.

Manner of determining practically the beginning of the Solar year.

By the *yaga Hershana* or *Spica Virginis*.

The time by the *yaga Vaidhrity*.

(*) Some pretend that this coincidence took place 29 years later; but with these contending opinions we have at present nothing to do.

when it is supposed to pass the Meridian any where at midnight, it should mark the mean Sydercal beginning of the Tamil month *Arpeti*, from which that of the year may be deduced; but I believe that in present times Indian Astronomers make little use of any Star for improving their account of time, or their general system of Astronomy (*), and that they content themselves for all purposes, Civil as well as Astronomical, to observe the heavens in their Books and Tables. There can be little doubt that this opposition of *Herahana* (Spica π) and coincidence of *Vaidhetig* (χ Piscium) to end with the commencement of the Hindu Solar Zodiac, never had the precision which the Indians assign to them; enough has been said, however, to show that the manner of fixing the commencement of the Solar year indicated in the Rule given at page 8, cannot it to anticipate in present times the moment of the Sun's entrance into the sign *Mesha* (γ) according to their own *Ayananta*, by an assignable quantity of no difficult resolution.

SECTION II.

Account of the Tables.

This Section is exclusively confined to the consideration of the various processes and Tables by means of which the initial *series* or *roots* of the beginning of Tamil years and months, treated of in the preceding Section, may be expended into *monthly dates*, of the Christian Kalendars, for any epoch whatever; without which Hindu Astronomy can only be to Europeans a subject of learned discussion, the resolution of which can be of no sort of assistance for penetrating into the depths of Hindu Chronology, or for affording Indians any means for getting access into ours.

The following subject, although of vital importance to the utility of the rest of the work, will therefore neither gratify the curiosity of scientific men, nor serve to elicit the polemic powers of Schollasts. The Rules and Tables hereafter disclosed consider both the Julian and Gregorian accounts: the first of these could not be dispensed with, because the Julian Style was only discontinued on the Continent of Europe on the 4th October 1582, when ten days were retrenched

(*) There will be found a Note at the end of the Volume, wherein it is shewn how the beginning of any Hindu Solar year, as accounted in the Arian Siddhanta, may be so equated that the Sun's mean Longitude, as elicited by the European Tables for that instant of time, be in all cases equal to the *Ayananta* due to the proposed year. Now having equated the time of beginning of the Solar year 3601 (A. D. 409) by the formula given in that Note, the equation was found to be 23 11h 16m 57s. Eur. Time, or Indian $\pi. \sigma. \gamma. \pi.$
Time

But the equation by *Herahana* was 23 10h 7m or

Hence there is still a difference of

or in European Time 5h 30m 2s.

$$\begin{array}{r}
 + 2\ 28\ 12\ 24 \\
 + 2\ 50\ 17\ 30 \\
 \hline
 22\ 5\ 0
 \end{array}$$

from the said month, and until the 29th March 1752 when the same style was adopted in England, and eleven days were retrenched for the same reason as had determined the Gregorian reformation.

The first step towards the attainment of that object is, to establish some expeditious method for expounding the monthly date of any feria (or weekly day) that may be proposed in past, present and future times, according to the two European accounts above mentioned; and the most obvious instrument for that purpose is the *Dominical Letter*. But as the usual process for eliciting it is somewhat operose (*) and would take a great deal more time than the whole resolutions of the problem, I have constructed two Tables which, in the space of less than three minutes, will enable the computer to elicit the same, for any year whatever, with equal certainty.

The Dominical Letter.

I shall now proceed to give an account of the Tables belonging to the present Memoir.

Explanation of the Tables.

Table I and II, page 1 and 2 of the Tables.

I notice these two Tables together, because they are both of the invention of *Father Reachi*, and are found in the same page of his manuscript tract on the *Division of Time* according to the Tamulæ. The first I shall consider in the present article; the second will be noticed in that which treats of the Cycle of 90 years, used in the Southern Provinces.

Table I gives at top of the 1st column, the Root of the *Ahargana* for the year of the Cali yug 4802, complete: the other quantities in the second column are the Roots of years from 1 to 100 collectively taken, the figures between parenthesis being the remainder of the sum of days after division by 7, to be counted from Sunday in order to have the initial feria sought.

If therefore it be proposed to compute the end of any year of the Cali yug, which let it be 4866, take 4802 therefrom; and if to the quantity which marks the epoch in the 2d. column you add 44 years (the difference), the sum will be the Root of the end of the year 4866, or commencement

(*) The following technical Rule in artificial verse, extracted from Hutton's Dictionary, will enable the reader to see that of the processes which he prefers, observing that the Dominical Letters of the ancient Julian Kalendar is 4 places before that of the Gregorian, the Letter A in the former answering to D in the latter. (Mathematical Dictionary, vol. I. page 393.)

" Divide the centuries by 4; and twice what does remain

" Take from 6; and then add to the number you gain

" Their odd years and their 4th; which dividing by 7,

" What is left take from 7, the letter is given."

M. B.—The Julian and Gregorian Dominical Letters for every year from A. D. 1600 to 1900 being given in the Solar General Table, the trouble of finding the same either by Hutton's rule, or that indicated in the text, becomes unnecessary, for any of the years of the XVIIth, XVIIIth, or XIXth centuries.

of 4847; and if from the latter you subtract 3102 you will have 1745, the year of Christ corresponding thereto.

But as Beschi always computed the end of the Indian Solar year by means of the Christian one, in order to elicit the former complete, he retrenched one year from the latter, and used 3103 the current year of the Cali yug, instead of 3101 the last expired on the birth of Christ, as has been observed at page 17. The epoch given in Table I as that for 1700, is therefore truly that due to 1701.

EXAMPLE.

Let the beginning of the Tamil year which concurs with A. D. 1745 Gregorian Style, be required.

The year of the Cali yug for computation, as was shown at page 17, will be $1745-1=1744$, or $1744+3102=4846$ complete, if we use Table I; but if Table VII (page 9), it will be 1745, both of which we will use once for the sake of exemplification.

By Table I.

Epoch A. D.	n.	c.	v.	p.
1700	(6)	2	11	15
40	(1)	20	50	0
4	(5)	2	5	0
Root	(5)	23	6	15

By Table VII.

Epoch Cali yug	n.	c.	v.	p.
4802	(4)	46	40	0
40	(1)	20	50	0
5	(6)	17	30	15
of Ahargana	(5)	25	6	15

which being counted from Sunday indicates Friday the initial seria of the month Chaitram and year 4847 of the Cali yug. The reader may therefore, use either Table as may best suit his convenience.

It need hardly be said, that the quantities in the second column are the Roots for one, two, three, four, &c. years, after division of the days by 7: thus $15\frac{1}{2}=52$ weeks + (1) day, the Root for one year independently of the fraction $15\frac{1}{2} 31\frac{1}{2} 15\frac{1}{2}$, and $365\frac{1}{2} 15\frac{1}{2} 31\frac{1}{2} 15\frac{1}{2} \times 100=36525\frac{1}{2} 52\frac{1}{2} 5\frac{1}{2}$ Op and $21522\frac{1}{2}=5217$ weeks with a remainder of (6) being the Root for 100 years, independently of the fraction $52\frac{1}{2} 5\frac{1}{2}$ Op.

Table III, page 3 of the Tables.

The contents of this Table will be better learnt by inspection, than by any explanation. I shall briefly state at this place, that in the first column will be found the abstract duration of each of the twelve months of the year according to the Ariah Siddhanta, and as reckoned by the modern Hindu Astronomers, in the present position of the Sun's Apsis and Ayananas.

In the second column will be found the Roots of the same as already explained, and in the third, are registered the collective Roots of the months as they advance in the year.

Thus the abstract duration of Chaitram (᳚), and consequently its end, being indicated by the Root

(2)	55	32	1
(3)	24	12	1
(6)	19	44	2

And the duration of Vaisak (᳚) being

the collective Root for the end of *Viassei* will be (5)^d 10c 44r 2p which is the second Root entered in the third column opposite to the Tamil month *Viassei*, and Hindu month *Jaishtia*, the Sun being then leaving the Sign *Vrisha* 8, and entering *Midhuna* II.

The utility of the third column need not be insisted upon; for it is manifest that if the Root for the end of the Solar month *Aurani*, or the beginning of the following month *Parattai* were required, and if the positive Root of the 1st Chaitram and year for A. C. 4817 were, as before found (page 22)

You need only take out of the 3d column the collective Root

(0) 51 50 21

And adding both, you have - - - - - at once the Root for the beginning of *Parattai* of the said year, instead of having to add successively those for *Viassei*, *Auni*, *Audi* and *Aurani*, found in the second column.

Table IV, page 5 of the Tables.

This Table serves to convert hours, minutes and seconds, from one sort of time to the other. It is calculated on the respective European and Hindu division of the day, the former into 24 hours, the latter into 60 guddias, subdivided sexagesimally into viguddias, paras, suras, &c. It requires no particular explanation, and the example given at the foot of the Table will suffice to show its application.

Table V, page 6 of the Tables.

It may justly be observed, that the Dominical Letter being a contrivance of European invention, and the manner of finding it for any year that may be proposed being known to the meanest Almanac maker, a separate article on that subject in this work appears superfluous. On due consideration, however, I found it so essential to the resolution of all Hindu problems of Astronomy and Chronology, and the methods now in use for expounding it so very tedious, that I could not dispense from treating of it in a particular manner before entering into the practical part of this Memoir.

Table V is divided into two parts, the first of which shews the Dominical Letter, and day of the week beginning each Julian Secular year from A. D. 0 to 2000; or from A. Cali yug 3102 to 5102.

Period beginning the centuries.

The second part shews the same for the *Gregorian* Secular years from A. D. 1500 (before which epoch that Cycle was unknown) to A. D. 2000; or from A. Cali yugam 4602 to 5102, which I call the initial *feria* of the century from which the commencement of the Hindu odd years, cannot deviate more than 3 days of the *Julian*, and 4 days of the *Gregorian* Kalendars.

The last section of this Table exhibits the same data from A. D. 0, to A. Ante Christum 4004, the epoch of the Creation, according to European Chronology: concurring with A. Ante Cali yugam 903-2.

Table VI, page 8 of the Tables.

Feria which begins the proposed European year.

This, like Table V, is divided into two parts, the first of which gives the number of days to be added to that which begins the century, in order to have the weekly day on which any of its odd years begin, according to the Julian Kalendar. The second part gives the same according to the Gregorian Style; and both give furthermore the day to be subtracted from the weekly day which begins the century, according as the years are Common or Bissextile, for any year before Christ, Julian Style. (*)

The figures in the body of this Table are so disposed, that they correspond to the number of days (0. 1. 2. 3. 4. 5. 6.) in the transverse column at top, which shews the number of *ferias* to be applied as before said.

It may be expedient to warn the reader in this place, that the application of these Tables is much more simple than their necessary explanation seems to imply. Attention is only to be paid whether the date is to be expounded in *old* or *new style*, *before* or *after* Christ, to prevent confusion. The process according to the various cases is the same, the side of the Tables only varies. But as the mechanism of this Memoir hangs principally on Table V and VI, an attentive perusal of the following examples is recommended.

EXAMPLE I. (Julian Style).

How to determine the weekly day on which the European year begins, and deduce the Dominical Letter therefrom.

Let it be required to determine on what *weekly day* the year 1745 O. S. begins, in order to deduce the Dominical Letter therefrom.

1^o Table V shows, part 1st, that the Julian year 1700 began on a *Monday* (the initial *feria* of the XVIIIth century). Now enter Table VI, part 1st, with 45 odd years; you will find over it in the transverse column at top the figure 1, which shews that one day is to be added to *Monday*, in order to have the *feria* beginning the Julian year 1745: i. e. *Tuesday*.

Having got this step and using any Kalendar wherein the Dominical Letters are inserted (vide Table IX, page 12. Kalendar at the end) and taking the first letter A (which always begins the year) to represent *Tuesday*, you find that the Julian Dominical Letter for A. D. 1745 is F; and consequently that for the ensuing year, (which is necessary for expounding the three last months of the Tamil year) will be E.

2^d Part.

Let the Dominical Letter for the same year be required according to the Gregorian Style.

Table V, part 2, shews that the 18th century began on a *Friday* (the *feria* for A. D. 1700).

With 45 odd years enter Table VI, part 2^d, you find over that number in the transverse column at top, 0; which shews that A. D. 1745 Gregorian Style, also begins on a *Friday*.

(*) The years after Christ do not require that distinction.

(†) This Table is in all cases to be entered with the proposed *old* Christian year, over a complete century.

Any Kalendar will therefore shew that since A (the first Letter in the year) represents *Friday*, C is the Gregorian Dominical Letter for the proposed year 1745, and that B is that for the following year 1746.

EXAMPLE II.

The same for the feria beginning A. D. 1815, *Julian Style*.

By Table V, part 1st, the 19th century begins on a *Sunday* (the initial feria for A. D. 1800) (*).

Referring to Table VI, part 1st, with 15 odd years, you find 5 over it, to be counted from *Sunday*, i. e. *Friday*, the feria beginning the proposed year; which shews as before, that the Dominical Letter, *Julian Style*, is C, and the following BA, because 1816 is a *Leap year*.

2d Part (Gregorian Style.)

By Table V, part 2d, the 19th century begins on a *Wednesday*; and by Table VI, part 2d, (†) 15 odd years give 4, to be counted from *Wednesday*; therefore the year 1815, *Gregorian Style*, begins on a *Sunday*, and the Dominical Letter is A, and the following year 1816, is GF, for the same reason as before stated.

OBSERVATION.

As the 17th, 21st, 25th, 29th and 33d centuries, *Gregorian Style*, begin with *Bissextile* years, the 1st part of Table VI, instead of the 2d, is to be used, because from that circumstance these years are assimilated to the *Julian Style*, the *Secular years* of which are all *Bissextile*.

EXAMPLE III (Gregorian Style.)

Let the beginning of the year 1601 N. S. be proposed.

Table V, part 2d, shews that the 17th century begins on a *Saturday* (the initial feria for A. D. 1600).

But Table VI, part 1st, for 1 odd year, gives 2, which added to *Saturday*, gives *Monday*, which is the weekly day beginning the year 1601, and whose Dominical Letter is therefore G, and that for the following year F.

EXAMPLE IV.

Let the beginning of the year 1699 N. S. be proposed.

Table V, part 2d, shews that the 17th century begins on a *Saturday*.

But Table VI, part 1st, for 99 odd years gives 3; which added to *Saturday*, shews that the feria beginning the year 1699, is *Thursday*; and consequently the Dominical Letter for that year, *Gregorian Style*, is D, and the following one C.

For the Gregorian years

1600
1700
1800
1900
2000

the 1st part of Table VI is to be used.

(*) With A. D. 1800 refer to Table V, part 1st, and you find in column 3d that the 1st January of the said year falls on *Sunday* *Julian Style*; the Dominical Letters being AG.

(†) With the same year refer to Table V, part 2d, and in the first column you find *Wednesday*, which is the initial feria of A. D. 1800 *Gregorian Style*; the Dominical Letter for that year being E.

Thus a very expeditious method has been instituted for finding the Dominical Letter, and expounding all the months and days in any given year since the birth of our Saviour, according to both European accounts, so that the only further attention which is to be paid, is to notice whether the year that follows the proposed one (the Dominical Letter of which is required for expounding the beginnings of Tye Ψ , Maussel \equiv and Poongoni \times), be a *Common* or a *Bissextile* one.

Attention to be paid to the Dominical Letter of the following year, whether it be *Common* or *Bissextile*.

Expounding of Dominical Letters for any time before Christ.

We are now to consider how the Dominical Letter for any year before Christ, is to be determined; and this is also done by help of Table V and VI, with the following modifications.

As the years are counted *increasing* when ascending from the birth of our Saviour, instead of *descending* and *increasing* in the contrary case, the numbers to be taken out of Table VI, part 1st and 2d, are to be subtracted from, instead of added to, the weekly day commencing the century, for having that which begins the given year. The following Rule will provide for this case.

Rule.

- 1^o If the given year be a *Common* one, use part 2d of Table VI.
- 2^o If the given year be a *Bissextile* one, then use part 1st of Table VI.

*

EXAMPLE V.

Let the Dominical Letter for the year before Christ 550 be proposed. That year not being divisible by 4, without a remainder, is a *Common* one; therefore part 2d, Table VI, is to be used.

By Table V, part 3d, we find that the year before Christ 500 (Julian Style) begins on a *Tuesday*, and Table VI, part 2d, for 50 years gives 6, to be subtracted from *Tuesday*, i. e. *Wednesday*; therefore the Dominical Letter for the year 550 (the 50th of its own century) is E, and that for 549 is D.

EXAMPLE VI, page 8 of the Tables.

Let the Dominical Letter for the year 636 before Christ be proposed. That number being divisible by 4, without a remainder, the year is *Bissextile*, and therefore part 1st, Table VI, is to be used.

Now Table V, part 3d, shews that the year before Christ 600 began on a *Wednesday*, and Table VI, part 1st, for 36 years gives 3 to be subtracted from *Wednesday*, i. e. *Sunday*, therefore the Dominical Letters for the year 636 Ante Christum are AG.

N. B.—The cause of this difference is occasioned by the order of the years counted before Christ being reversed, and that the second Letter when the year is *Bissextile*, is to be taken in *Ante^{ced}entia*, instead of *Consequentia*, as is done for years after Christ.—Thus, if G were the Letter produced by the Rule for years before Christ, the second Dominical Letter would be F; but in ascending from the same, that Letter will still be G (as given by part 1st, Table VI), and the second Letter must be A. If we use part 1st, instead of 2d, there will be no possibility of a mistake.

How to determine the monthly by means of the weekly date.

Having thus found means to elicit the Dominical Letter for any given year in all possible cases.

Be a common year.

Be a Bissextile year.

and styles, there remains no difficulty for finding the feria on which any monthly date of the same year may fall. But the converse of the proposition is by no means so apparent, because as we have seen, the manner of fixing the beginning of any year or month, according to the precepts of Hindu Astronomy, whether Lunar or Solar, is by determining the feria on which such an occurrence falls; and as there are four weeks and a fraction in every month, there is a doubt on which of these, the weekly day elicited by the Rule may fall.

For the resolution of this problem we are to have recourse to the General Index, the theory of which was given Article 5, page 15, and to Table V and VI, as shown in the following examples.

EXAMPLE I.

Suppose that we have found by the Rule given at page 8, that the 1st Chaitram and year 4830 fell on a *Sucra-vara* (Friday), what may the monthly date of this Friday be?

I.

For the Dominical Letter, and the Christian year to be registered, we have $4830 - 3102 = 1728$, and let the *Julian* date be first required.

II.

Table V, part 1st, shows that the 18th century began on a *Monday*.

Table VI, part 1st, for 28 odd years, gives 0; therefore the year 1728 began also on a *Monday* and the Dominical Letters (the year being a Bissextile one) are GF.

III.

Again Table V, part 1st, shows that the year *Calī yugam* 4802 current (corresponding to our Secular year 1700) began on the 28th March O. S. and the year 4902 on the 20th of the same month, therefore the Friday sought must fall within two days of either of these two dates, and referring to the Kalendars, it is found to fall on the 29th March O. S.

Q. E. I.

EXAMPLE II.

The same, *Gregorian Style*.

I.

Table V, part 2d, shows that the 18th century *New Style*, began on a *Friday*.

Table VI, part 2d, for 28 odd years gives 6 days, therefore the year 1728 began on a *Thursday* and the Dominical Letters were DC.

II.

Again Table V, part 2d, shows that the year *Calī yugam* 4802 began on the 8th of April, and 4902 on the 10th of the same month, therefore 4830 must have begun within two days of those limits; and referring to a Kalendar we find, that the given *Sucra-vara* (Friday) fell on the 9th April 1728.

Q. E. I.

Examples might be multiplied, but as as the process (which is extremely simple) is in all cases the same, I shall turn to the resolution of the beginning of the last eleven months of the year.

SECTION III.

Account of the Tables continued.

Revelation of the
last eleven months
of the year.

We have shown at page 15, that the beginning of the Tamul year, when resolved into European time, is an Index which indicates the limits between which the first day of every month, besides *Chaitram*, must fall, in its proper concurrent month; and that the monthly date sought never recedes more than two days from the same (in the particular cases of the month *Masui* = and *Poonigoni* ✕), and never exceeds it for the remaining 10 months more than four days. On this data we proceed as follows:

EXAMPLE I.

Let it be proposed to expound on what month and day of our Gregorian year 1745, *Ravi-vara*, 1st Paratasi ♀, A. Cm. 4847, happens to fall.

1.

We find by Table III, that the Tamul month Paratasi, concurs with our month September; and by the Rule at the foot of Table I, that the 1st Chaitram and year Call yugam 4847 began on a *Succa-vara* (Friday), which being expounded according to the Rule given in this Article, is found to fall on the 9th April Gregorian Style, and consequently that the 1st Paratasi of the said year cannot have fallen before the 9th, or after the 13th of September. Lastly, we have found that the Domical Letter for 1745 was C, and for 1746 B, N. S.

2.

With these data referring to any Kalendars, it follows that *Ravi-vara*, the Sunday to be expounded, falls on the 12th September 1745 Gregorian Style.

The same, Julian Style.

But if we require the date Old Style, having found that the beginning of the same year fell on *Succa-vara* (Friday) the 29th of March, and that the Domical Letter was F, reasoning as before, it will be found that the same *Ravi-vara* falls on Sunday the 1st September O. S.

Intermediate days
of any month have
to be registered.

With respect to the intermediate days of any month, it is plain that we need only count as many units as there are days between the 1st of the month and the given date, and add the sum to the European date, and vice versa, subject to what has been said on the duration of the Hindu months, at Article 5, page 15.

EXAMPLE II.

Thus it having been found that *Ravi-vara*, 1st Paratasi, A. Cm. 4847, fell on Sunday the 12th September 1745 N. S., if any other day, as *Mangala-vara*, 10th Paratasi, were proposed, there needs only to apply 9 days to the 12th of September, and we find that the proposed date falls on the 21st of the same month.

It is, however, to be remembered, that when any European date, whose concurrent may prove far advanced in the Tamul months, is to be expounded, as it is unknown of how many days the said month may be composed in the given year, there remains a doubt to which Hindu month the said date may belong, which to resolve, the beginning of the ensuing month must be expounded (vide Memoranda infra, page 30 and 31.)

When the European date falls near the end of the Hindu month, the beginning of the ensuing one is to be expounded and the dates established in *Asvatomit*.

Table VII, page 9.

Although the practice of counting by years of Christ was only introduced in Italy during the Vith century, and in the North of Europe towards the VIIIth, under Charlemagne; and even then, that there were no less than eight different manners of counting the years of Incarnation (vide *Art de Vérifier les dates*, page 11), yet Astronomers and Chronologists have found it expedient to establish an *ex post facto* Kalendar, which might serve as a common scale for measuring past and future ages, altho' such a scale were unknown in the times referred to. Thus European Astronomers have protracted the Julian Kalendar, for the purpose of extending their Sydercal Tables, up to the year 800 before Christ, because the ancient Chaldaic observations ascended to that epoch, having preferred that division of time to any other, on account of its being more simple, commodious and uniform. For the same reasons, I have been induced to extend the Tables of which Father Beschi was the original inventor, to the aforesaid, and higher epochs.

The only remark to be made on this Table is, that the two last columns give, viz. the second, the epochs for the Secular years from A. D. 0 to 2000, according to Beschi's method, and the third, the proper Roots for the same years, the only difference being, that the former are for one year later, than the latter, as has been hinted at page 17.—These elements were both given, although either one could have been sufficient for the purpose of preventing mistakes when departing from Beschi's system.

Table VIII, page 10 and 11 of the Tables.

This Table gives the *Epochs* and *Roots* of Secular years in ascending progress, from A. D. 0 to the Creation, as indicated in the respective columns.

The fourth column, 1st part, gives the absolute Root of the beginning of Chaitram and year for the first 10 years before Christ, i. e. from A. Cali yugam 3102 to 3112; and afterwards from 10 to 10 years, up to 3002, concurrent with Anno Ante Christum 100. The fourth and fifth columns of the second part of the same Table give, the former the Epochs, the latter the Roots for every century as far back as A. A. C. 1000, and subsequently from 1000 to 1000 years up to A. Ante Cali yugam 903.2, the epoch of the Creation.

Thus if the beginning of a year not given in the Table be required, take the Root of that nearest to it; and complete the Rule by adding thereto for the odd years taken out of Table I.

EXAMPLE.

I.

Let the beginning of Chaitram and year 28, Ante Christum, be required, concurrent with A. Cm. 3004.

	D.	C.	T.	P.
Root for A. C. 20, Table VIII, part 1st, column 1st			(5)	44 22 30
Subtract 8 years from Table I.			(3)	4 10 0
Beginning of Chaitram and year			Tuesday (2)	40 12 30

II.

Had we worked with the Epoch, Table VIII, part 2d, the operation would have been thus:

	D.	C.	T.	P.
Epoch A. D. 0, Table VIII.			(1)	16 46 15
Subtract for 20 years, Table I.			(1)	16 52 30
Subtract again for 9 years complete			(6)	59 53 45
Because by notation the years are increasing in ascending, Table I.			(4)	19 41 15
The same as before			(2)	40 12 30

TABLE IX, page 12.

Exhibits the Dominical Letter for every day in the year. It requires no explanation.

SECTION IV.

MEMORANDA to be referred to in expounding dates.

Note whether the given European date is likely to fall before or after 1st Chaitram.

19 In expounding any date of the month of March or April from European to Tamul time, it is necessary, before noting the concurrent year Cali yugam or Saca, to see whether it is likely to fall before or after the 1st of Chaitram, which begins about that time.

Thus suppose the 7th April 1745 N. S. had been propounded, the process indicated at page 18 would have been merely $1745 + 3102 = 4847$ (1668 Saca) current.

But as we may see (Example 1st, Part II infra), that the said year began on the 9th April, it is plain that in this case, the current years Cali yugam and Saca, must be noted *one less*, and that the given 7th April falls on some of the latter days of the month Poongoni A. Cm. 4846, or Saca 1667.

When the given date falls before that which begins the century, take 1-1 for the notation of the year.

20 When the given date falls before that which is indicated in Table V, part 2, as beginning the century, then as the beginnings of successive years proceed like the *Ayanansa* in *Consequencia* (*), it is manifest that the year Cali yugam or Saca, instead of being noted $x + 3102$, must be taken $(x-1) + 3102$.

(*) During the present Pada.

Thus if 3d April 1730 N. S. be proposed, since A. Cm. 4802 (1700—1) is shown in Table V to have begun on the 8th April, it is manifest that the notation of the year must be $(1730-1) + 3102 = 4831$; or $4851 - 3170 = 1672$ Saca, and not 4832 Cm. and 1673 Saca.

But if the proposed date be 9th April 1728, observing in Table V that 4802 (1700) begins on the 5th, and 4902 on the 10th of that month, there is a doubt to which of the years 4900 or 4899 Call yugam, the given one belongs; but the resolution of the beginning of 4900 ($1728 + 3102$) will at once resolve the question, and the year may be noted after the operation.

39. The notation of a date in *Antecedentia* (as in the preceding case) when it falls within four days from the nearest beginning of the month,—or in *Consequentia*, when it exceeds 28 days from the beginning of its own month, is also a matter of doubt, and must be resolved. In both cases this depends on the number of Kalendar days counted either in the preceding or in the current month. That is, if the proposed date happens to precede the 1st Chaitram (or any other month) by a few days, its notation in *Antecedentia* will depend on the number of Kalendar days counted in the preceding month Poongoni (or any other preceding month), which Poongoni varies from 30 to 31 days, not depending on the preceding year being a common, or a leap year, as is the case in the European Kalendar.

Notation of dates in antecedentia or consequentia, how to be determined.

Depends on the number of Kalendar days counted in the preceding or current month—and on a common or bissextile year.

In the same manner, if any date in *Paratati* exceeding the 28th, be proposed, it will be a matter of doubt whether it does fall in that month, or in the following *Arpeti*, because that month may vary from 30 to 32 days.

In this uncertainty, the number of Kalendar days in the month where the proposed day seems to fall after addition or subtraction, must be calculated.

EXAMPLE.

Suppose we have found by the usual process that the 9th April 1728 fell on the last day of the Tamil month Poongoni ☿; is it to be registered in the Tamil Kalendar the 30th or 31st of that month?

RULE.

The 1st Chaitram and year Call yugam 4900 (1728) having been found to fall D. a. v. r. on the 10th April, whose Root is - - - - - Tuesday (2) 7 42 30
Subtract therefrom the Root for Poongoni, Table III, part 2 - - - - - (3) 20 21 1
Beginning of Poongoni 4899 Cm. - - - - - (6) 47 21 28

Various lengths of the Tamil months,—the manner of determining the same.

Saturday, which expounded with its proper Dominical Letter G, falls on the 10th March; therefore, in the present case, the Kalendar month Poongoni has 31 days; and the date concurrent with the 9th of April is to be registered 31st Poongoni. But if we want its notation as a *Civil* day, considering that the fractional part of the sum which determines the beginning of Poongoni, viz. 47s 21v 28p exceeds 30 guddias, the Civil beginning of that month is to be registered and

Notation of the day in the Kalendar as a Civil day.

day later, i. e. on the 11th March. But as the fractional part of the Root of 1st Chaitram 4900 (78 42r 30p) is below 30r, both the Civil and Sydereal day coincided on the 10th April, which makes no room for the Civil advance of the 1st Poongani, and therefore the said Civil month will have counted only 30 days, and the proposed date, 9th April, must be registered the 30th of that month.

The reduction of epochs to different geographical positions postponed.

4o We should now consider the reduction of the epochs so computed for the Meridian of Lanca, to some other Meridian; which involves a great variety of considerations.

Rec'ha the Meridian of Lanca,

With respect to the mere difference of Longitude, the Indian is the same as the European process. They make their mean epochs to occur sooner or later, as the place computed for lies East or West of Lanca. The difference of Longitude of the principal places in India in degrees, Indian time and yojanas, will be found in Table XXXIII, page 43 of the Tables, as they are given in some of their Ephemerides, and will suffice to transfer the above mean epochs, from the Rec'ha (Meridian) of Lanca to any other Meridian.

But the case is quite different, when the true epochs, counted in apparent time from the instant of Sun rising, are to be determined (as they are in the Tamul Solar Kalender) for any particular place which has any geographical Latitude. For the resolution of this part of the problem, Hindu Astronomers have recourse to *Tropical Astronomy* and to *Gnomonics*, in which branch of the science they have shewn much ingenuity, and a respectable knowledge of Plane and Spherical Trigonometry. But the reader is not supposed sufficiently advanced in the knowledge of Hindu Astronomy, to enter now into such topics with any prospect of advantage. I shall, therefore, postpone what I have to say on this matter, to the time when we come to consider the theory and construction of the *Chandra Mana*, the Hindu Astronomical year, which is its proper province. Meanwhile, I shall observe that, for mere chronological purposes, such as the resolution of dates, what has been said in the preceding Articles will be found perfectly sufficient.



PART II.

To convert European into Tamul time, referred to a given Meridian.

NORMING can be more plain and simple than the Rule which elicits the weekly day marking the beginning of Chaitram and year, by means of the Tables: it remains the same and is equally expeditious for all possible cases near or remote, and may at pleasure be performed by addition or subtraction, as the computer may chuse to reckon from an antecedent or subsequent epoch. The result is equally certain, and as far as the day of the week is concerned it requires no Bija or Phala (correction or equation), like most other Hindu problems. Thus the Rule given at the foot of Table I, teaches us every thing required on this score; for if we take the epoch either from A. D. 1700 or 1800, viz.

Table I.			Table VII.		
Epoch 1700	-	(5) 2 11 15	Epoch 1800	(5) 54 16 15	
		(1) 20 30 0	Table I, 50x	—(5) 56 2 30	
		(5) 2 5 0		(5) 58 13 43	
Weekly day, Friday,	(5) 25	6 15	—6	(0) 53 7 30	
				(5) 25 6 15	

we have equally Friday arising out of the Root (5) counted from Sunday.

It would have been therefore superfluous to multiply examples, were it not for the resolution of the monthly European date concurring with the feria according to our reckoning, which (considering the interruption which our Kalendars are subject to from the introduction of bissextile years, and the two Styles) renders that part of the problem somewhat complicated.

The following Examples have therefore been chosen, to exhibit every possible case where the notation of the Dominical Letter, on which every thing depends, may require caution or distinction in order not to be mistaken. The perpetual and consequently fastidious repetition of the process will, I trust, be forgiven, on considering that the subject is a new one, and that when engaged in such operations, a reference to preceding Examples by diverting the attention, is always irksome and discouraging.

Generally, when the feria is known, a glance at Table V (last column of each division) will always show within the limits of *three days* for the Julian Kalendar, and *four days* for the Gregorian, on what monthly date the weekly day obtained by the foregoing Rule will fall. For if the Hindu year concurring with A. D. 1700, begins on the 18th, and 1800 on the 29th March

Old Style, then the Friday above elicited must fall between the 27th and 30th of the said month, and it accordingly concurs with the 29th. And if the same beginnings fall on the 8th and 10th April *New Style*, then the same Friday must concur between the 7th and 11th of that month, and so it falls on the 9th. When very remote epochs are considered this approximation will generally appear sufficient, but we are not therefore to neglect the means of attaining a greater degree of exactitude.

As whatever European date may be proposed to convert into Hindu time, is always clearly known to the computer by means of the particular designation it bears, a very slight attention to the notation of the date, to wit, whether it refers to before, or after the birth of our Saviour,—from the epoch of the Creation, or from that of the Hejira; also whether it be according to the Old or New Style, will be sufficient to remove any cause of uncertainty.

EXAMPLE I.

Let it be proposed to find the Tamil concurrent date to the 9th April 1745 Gregorian Style, under the Meridian of Lanka.

CAUTION.

Referring to Table V, part 2d, we find that in the Secular Christian year 1700, the Tamil year concurrent thereto began on the 8th April N. S., and in 1800 on the 10th of the same month, therefore the beginning of any year in the 18th century may fall from the 7th to the 11th April N. S.; but it is doubtful whether the given date will fall in A. Cali yugam ($1745 \div 3102 = 4847$, or in $1744 \div 3102 = 4846$. We must therefore reserve the notation of the year until we know on what day of our April the Sydercal beginning of A. Cn. 4847 will fall. (*)

RULE.

	D.	M.	D.	P.
Root for 1700, Table E.	-	-	-	-
40 years, do.	-	-	-	-
4 do. complete	-	-	-	-
End of 4846, or beginning of	-	-	-	-
4847 to be counted from Sunday, i. e. Friday.	(6)	2	11	15
	(1)	20	50	0
	(5)	2	5	0
	(3)	23	5	15

In order to find on which day of our April 1745 this Friday will fall, we are to proceed as follows:

Table V, part 2d, shews that the 18th century began on a Friday; and Table VI, part 2d, that 45 odd years give 0 day to be added thereto, in order to have the day of the week on which the year 1745 began, which therefore remains *Friday*, and shews that the Dominical Letter was C.

(*) Vide Memorandum 1st page 20. In all the following Examples the years Cali yugam and Saca are noted in the proposition as current; but the year complete is always used in the resolution. For if 1745 be proposed, and 1744 be used in the computation, it is clear that we work for Cali yugam 4846 ending or 4847 commencing.

Now reverting to Table V, part 2d, column 3d, we find that the beginning of the Tamul year 4802 (concurrent with 1700) fell on the 8th of April; and as it has been observed that the beginning of the concurrent year cannot exceed that date by more than three days, referring to any perpetual Kalendar with the Letter C in the beginning of April, we find that the Friday elicited by the present Rule fell on the 9th April N. S. Hence we have the following

ANSWER.

The 9th April A. D. 1745 N. S. is concurrent with the 1st Chaitram and year Cali yugam 4847 commencing, which shews the proper notation of the year.

N. B.—As the Gregorian Kalendar was only admitted in England in the year 1752, it may be necessary to resolve the question according to the Julian style, which is to be effected as follows:

The same according to the Julian Kalendar.

The Tamul Rule remaining as before, and the Root being *Friday* (5th) 25th 6th 15th a common year, we find by Table V, part 1st, that the Secular year 1700 O. S. began on a *Monday*, and for 45 odd years, Table VI, part 1st, gives one day to be added thereto, in order to have the weekly day beginning the year 1745 O. S. i. e. *Tuesday*, and consequently that the *Julian* Dominical Letter for that year is F.

Again, Table V, part 1st, column 5th, shews that the Tamul year Cali yugam 4802 concurrent with 1700, began on the 28th of March, and that of 4902 on the 29th of the same month; therefore 4847 must begin within the 27th and 30th, and entering the perpetual Kalendar with the Dominical Letter F about that time, we find that the *Friday* to be expounded falls on the 29th of March, &c.

EXAMPLE II.

Wanted the Tamul month and day corresponding to our 1st January 1813, Gregorian style, under the Meridian of Lanka.

As the proposed date falls considerably before the 1st of April, there can be no doubt but that we are to take $(1813-1) \div 3102 = 4914$ for the notation of the concurrent year Cali yugam (vide Memorandum 2, page 30) and that we are to work with 1812.

RULE.

	D.	C.	Y.	F.
With 1800 refer to Table VII, you find Epoch	(5)	54	16	15
Root for 10 years, Table I	(5)	35	12	30
Do. for 1 year complete	(1)	15	31	15
Beginning of year and Chaitram 4914,	(5)	45	0	0
	Friday, Sucra-vara,			
	a leap year.			
To get now to the month of Tye or (Tamul January), take out of Table III,				
part 3d; the Root for Margali 7, complete	(2)	59	30	11
Beginning of Tye	(1)	24	30	11
	Monday Soma-vara.			

In order to find the monthly date of this *Soma-vara*, we must first determine that of the Friday on which the 1st Chaitram 4914, happens to fall.

Proceeding as formerly directed, we find by Table V that the 19th century began on a *Wednesday*, Gregorian Style: and Table VI, part 2d, shews that for 12 years 0 day is to be added thereto, in order to have the weekly day which begins the given year; therefore, A. D. 1812 also began on a *Wednesday*, and consequently the Dominical Letters (the year being bissextile) are ED; and lastly, as the date proposed falls on the beginning of the ensuing year, the Dominical Letter to be used is C when expounding the three last months of A. Cm. 4914 (1813.)

Now by Table V, part 2d, column 3d, it appears that on the Secular year 1800, the Tamul year began on the 10th April, and for 1900 on the 12th of the same month. Therefore, referring to any perpetual Kalendar with the Letter D, we find that Friday, 1st Chaitram 4914, falls on the 10th of April 1812.

Again, the Rule in the present Article has shewn, that the month *Tye vṛ* (Indian January), falls on a *Monday* (*Soma-vara*).

But since the month Chaitram began on the 10th April, no other month in the same year (beside Maussai, which always begins one day sooner) can commence in its own concurrent month later than the 14th (vide page 8), and as we refer to the first days of our January 1813, the Dominical Letter to be used is no longer D, but C. Hence, referring to the perpetual Kalendar with that Letter in the beginning of January, we find that the proposed *Monday* falls on the 11th January 1813 N. S. the concurrent date to 1st *Tye* 4914.

But the date which is proposed is the 1st January; we have, therefore, an excess of 10 days, which will throw its concurrent Tamul date in the month of Margali १ (Indian December) and must be resolved in *Anṭarāntika*. (vide Mem. 3e page 31).

In order to have the correct date in Margali after subtraction of 10 days, we must determine how many Kalendar days in the given Tamul year, that month contains, for which purpose we have the following process.

By Rule (present Article) we have the Root for 1st <i>Tye vṛ</i> , A. Cm. 4914	3	2	1	2
Subtract Root for Margali, Table III,	(1)	24	30	11
	(1)	20	53	1
Beginning of Margali,				
				Ravi-vara (0) 3 37 10
for which using the Dominical Letter D (because Margali is concurrent with December 1812)				
we find Sunday 13th December. Hence				314 in December.
				— 13
				18 rem. in Dec.
And as <i>Tye</i> began 11th January				11 in Jan.
Number of days in the month Margali				20
From which subtract				10 in excess
				There remains 10

ANSWER.

The 1st of January 1813 falls on *Sacra-vara* (Friday), 19th Margali, A. Cm. 4914.

N. B.—It will be found by adding the Roots of the months *Tye*, *Maasi*, and *Poongoni*, Table III, part 2d, to that of the beginning of *Tye*, found in the present Article, that the ensuing year 4913 and *Chaitram*, falls on Sunday, 11th April 1813, which shows that the operation has been well performed (vide General Table of Solar years XIXth century, at the end).

EXAMPLE III.

In the year of Christ 800, Easter Sunday fell on the 19th April Julian Style, Alexandrian computation : wanted the Hindu date thereof.

As it appears from Table V, part 1st, that the Tamil year *Call yugam* 3902 concurrent with A. D. 800, began on (Wednesday) *Bhadravara*, the 20th March O. S. and that the Dominical Letters were ED, no further calculation is required for the 1st *Chaitram* of the said year.

But the proposed date is the 19th April, which is 30 days more, therefore the date required should fall on the 31st *Chaitram*, provided that month contains that number of Kalendar days ; to ascertain which we have, as before, the following process.

	D.	G.	T.	P.
Epoch 800, Table VII,	(0)	13	26	15
Subtract one year for the Root, Table I, (vide Part I, page 13),	(1)	15	31	15
Beginning of <i>Chaitram</i> A. Cm. 3902	Friday (5)	57	55	0
If we wish to verify the operation to the above last Root	Friday (5)	57	55	0
Add Root for the month <i>Chaitram</i>	(2)	55	32	1
	Monday (1)	53	27	1

which Monday being expounded by means of the Dominical Letter D, about 20th April, (because the preceding month began 20th March) we find 1st *Vjaseei* 8 on the said 20th April,—therefore the month of *Chaitram* counts 31 days, and the Tamil date *Ravi-vara*, 31st *Chaitram*, answering to Sunday, 19th April, A. D. 800, has been well expounded.

EXAMPLE IV.

A Missionary wants to determine on what Kalendar Tamil year, month and day, Christmas day A. D. 1812 Gregorian style, happens to fall; and wishes to note the current year from the epoch *Saca*, that of the birth of *Salivahana*.

RULE.

The year *Call yugam* current with A. D. 1812 (1812 ÷ 3102) is 4914 current ; but from what has been said at page 17, the concurrent year *Saca* is (4914—3179) 1735.

To proceed, using as before 1812—1.

	D.	G.	V.	F.
Epoch for 1800, Table VII,	(6)	54	15	15
Add Root for 10 years, Table I,	(3)	35	12	30
Do. for 1 year complete, do.	(1)	15	31	15

Beginning of Chaitram and year Saka 1735 - Friday (5) 45 0 0
a leap year.

And to get to Margali, (Indian December) add Root for
Cartia complete, Table III, part 2d, (1) 13 37 1

Beginning of Margali - Sunday (0) 3 37 1

We are now to expound these, Friday, 1st Chaitram, and Sunday, 1st Margali, for which Table V, part 2d, shows that the 19th century begins on a *Wednesday*, and Table VI, part 2d, that for 12 odd years 0 is to be added to the said *Wednesday*, to have the day of the week on which A. D. 1812 begins; which therefore also occurs on a *Wednesday*, and gives the Dominical Letter ED, that year being bissextile.

Now it appears by Table V, part 2d, column 3d, (page 6,) that the year Call yugam 4903 (1800) begins on the 10th April N. S. and 5002 on the 12th, therefore the proposed year must fall about the 9th and 13th, which are its limits; and for reasons already referred to, that the 1st of Margali cannot occur earlier in December than the 9th, or later than the 14th.

With these data refer to the perpetual Kalender with the Dominical Letter D, and you have

Friday, 1st Chaitram, and year Saka 1745 - 10th April,
Sunday, 1st Margali, - do. 13th December.

But the proposed date is 25th December, which is 12 days later, therefore Christmas day A. D. 1812, falls on Sacra.vara, 13th Margali of the year Saka 1735.

EXAMPLE V.

The epoch of Hejiz, or flight of Mahomed, occurred on the 12th July A. D. 622 Julian Style: wanted its concurrent Hindu date.

CAUTION.

As the proposed date falls considerably beyond the beginning of April, there can be no question as to the notation of the years Call yugam and Saka, which are, viz. Call yug (622+3102) 3724 and Saka (3724—3179) 545, both current.

RULE.

	D.	G.	V.	F.
Epoch for the Secular year 600, Table VII,	(0)	29	16	15
Root for 20 years, Table I,	(4)	10	25	0
Do. for 1 year complete,	(1)	15	31	15
Sydercal beginning of Chaitram and year Cm. 3724 - Friday, (5) 55 12 30				

a leap year.

Audi to get to the Indian month Audi (☾) June, add Root of	d.	c.	t.	r.
Audi II complete, Table III, part 2d,	(2)	23	21	0
Beginning of Audi A. Cm. 3724	-	-	-	Monday, (1) 21 21 25

Now to expound the Christian date of the 1st Chaitram and 1st Audi, we find by Table V, part 1st, that the Secular year 600 Julian Style, began on a Friday, and by Table VI, that 22 odd years give 0 day to add thereto, in order to obtain the feria beginning A. D. 622, which therefore also begins on a *Friday*. Hence the Dominical Letter is C, Julian Style.

But Table V, part 1st, shews that the year Cali yugam 3702 (600) began on the 19th March, and 3802 on the 20th, therefore 1st Chaitram 3724, must fall about either of those days (page 15).

Referring therefore to the perpetual Kalendar with the Letter C, near the 19th March, we find *Friday*, 19th March, for the beginning required.

In the same manner, since the beginning of Audi cannot fall before the 19th, nor after the 23d of June (vide Example II and IV), the same process shews that Monday, 1st Audi, falls on the 21st June; and therefore, as the proposed date is the 16th July, that it will fall 25 days later, i. e. on the 26th of Audi.

ANSWER.

The 16th July A. D. 622 falls on *Satya-nara*, the 26th Audi, of the 3724th year of the Cali yug, and 342 Saca.

NOTE.—Too much attention cannot be paid when converting dates proposed in the *Julian style* into the corresponding date of the *Tamil Solar year*. For although there is no danger of mistaking the European month which corresponds with the 1st Chaitram of the year sought, its being always clearly indicated by Table V, yet if the proposed date be advanced in the year, as is the case in this Example, the eye, on taking out the European month, which let it be that corresponding to Audi, out of Table III, may hit on the 2d Section of that Table, where Audi corresponds to July N. S., instead of the 1st, where it answers to *June Old Style*.

Thus in the present Example, if through mistake the month *Audi* were taken to answer to our *July* (as it does in the Gregorian), instead of *June*, which is the corresponding month of the Julian Style, then the 16th July would be made to fall on the 20th *Auni* instead of the 26th Audi, which is its correct date.

EXAMPLE VI.

An European lets a house on lease to a Native, for a certain period of time, which is to expire on the 11th April 1833; the Native wants to know on what year, month and day of his own reckoning, his lease is to expire.

OBSERVATION.

As the year *Om*. 5002 (1900.1) begins on the 12th April (Table V), there can be no doubt about the notation of the year, which must be (1838+3102) 4940 *Calī yugam*, or (4943—3173) 1761 *Saka*, both current.

RULE.

							D.	C.	T.	P.
Epoch for 1800, Table VII,	-	-	-	-	-	-	(5)	54	16	15
Root for 30 years, Table I,	-	-	-	-	-	-	(2)	46	37	30
Do. for 7 years complete, do.	-	-	-	-	-	-	(1)	48	38	45
Beginning of <i>Chaltrām</i> and year 1761 <i>Saka</i> or <i>Calī yug</i> 4940	-	-	-	-	-	-	Wednesday (3)	28	32	30

a common year.

To expound which, we find by Table V, part 2, that the 19th century begins on a *Wednesday*; and by Table VI, for 58 years, that 5 days are to be added to the same for the feria beginning *A. D.* 1838, i. e. *Monday*; therefore the Dominical Letter for that year is *G*, Gregorian Style.

Now the Hindu year 4902 concurrent with 1800, begins on the 10th April, and 5002 on the 12th, therefore the commencement of 4940 must fall about these limits.

Referring, therefore, to the *Kalendar* with the Dominical Letter *G*, near that date, we find that *Wednesday*, 1st *Chaltrām*, falls on the 11th April, which is precisely the given date.

ANSWER.

The Native is to surrender the house on *Monday*, 1st *Chaltrām*, *A. Calī yug* 4940, and *Saka* 1761.

EXAMPLE VII.

The Chronologists reckon that our Saviour was born on the 5th year before *Anno D. Dionysian* era, from which circumstance we account our time 5 years too late. What is the concurrent Hindu date with Christmas night of the said year?

CAUTION.

1^o We are to notice when taking the Roots out of Table VIII for the odd years before Christ, that as the centuries are increasing in notation whilst ascending, *one more* odd year is to be used for the end of the year expired, instead of *one less*. Thus had the proposed year been *A. D.* 5 current, we would have used 4 complete; but having to expound *A. A. C.* 5, we are to use 5.

2^o The given year is a *common one*.

3^o The proposed month falls considerably after April; and the notation for the year will therefore be (3102—6) 3096 complete, and 3097 current.

RULE.

Table V, part 3d, shows that the secular year *Ante Christian Era* 100, began on a *Friday*, and its Dominical Letters are *CB*; the same Table shows also, that the Hindu year *Calī yugam* 3003 concurrent therewith, began on the 13th of March Julian Style.

With the year *Call yugam* 3095 complete, referring to Table VII, we find at once (not the epoch) but the Root for the proposed year.

	d.	c.	t.	r.
Sunday (C)	43	28	43	

And to get to the Indian month of December, referred to the Old or

Julian Style, take the Root for Margali, Table III,	-	-	(2)	39	50	11
---	---	---	-----	----	----	----

1st Tye <i>vf</i> to be counted from Sunday, i. e. <i>Wednesday</i>	-	-	(3)	23	8	35
---	---	---	-----	----	---	----

To expound which, we have noticed that the beginning of A. A. C. 100 began on a *Friday*; and Table VI, part 1st (the year being a common one) for 25 odd years gives 0 to be added to the same for the feria beginning A. A. C. 5, which therefore also commences on a *Friday*, and the Dominical Letter is C.

Again Table V, part 2d, shows that the Hindu Solar year 3092, concurrent with A. A. C. 100.1, began on the 13th March, and 3102 on the 14th, therefore 3097 must have begun near either of these monthly dates. Referring therefore, to the Calendar with the Dominical Letter C about that time, we find that Sunday, 1st Chaitram and year, fell on the 14th of March.

And as this is an Index which shows that the other months cannot have begun earlier than the 12th, or later than the 17th, in their respective months (vide Example II and IV), the same process will show that *Wednesday*, 1st Tye, fell on the 15th of December. We want, therefore, 10 days from the proposed date (25th December), which added to 1st Tye, the sum gives *Saturday* the 11th of the said month.

ANSWER.

The 25th December A. A. C. (the day on which our Saviour was born) answers to Sani, vara, the 11th Tye of the 3097th year of the *Call yug* current.

EXAMPLE VIII.

There was a total Eclipse of the Moon on the 15th May 1631 Gregorian Style. What day was reckoned in the Hindu Calendar when this Eclipse occurred?

REMARK.

Here we are to distinguish between computing the time of an Eclipse, which is to be effected by the resolution of time on principles totally different from those which regulate the *Madhyama Saura Manu*, and expounding the day which was reckoned in any Calendar, (let it be ever so erroneous) when that event occurred. An Eclipse which was observed on any particular day cannot be controlled by any system of Astronomy; and its prediction, when determined on legitimate principles, can only fail by a very small quantity: it may therefore, be classed with actual observation. The present question is, therefore, only one of Chronology, and not of

Astronomy ; for it being known that the Eclipse occurred on a *Thursday*, all we have to do is, to determine what date this *Thursday* did indicate in the Tamil Kalendar, to resolve it.

This being understood, we shall proceed as usual.

CAUTION.

1^o As the Secular year 1600 Gregorian Style, was a *Bissextile* one, we are to use part 1st of Table VI for the number of days to be added to the weekly day beginning the century, to have that which commences the given year (or any other year of the same century).

2^o The proposed date falling in *May*, leaves no doubt respecting the notation of the year, which should be (1631+3102) 4733 Cali yugam and (4733—3179) 1554 Saca, both current : then with 1631—1.

RULE.

	D.	C.	V.	P.
Epoch for A. D. 1600, Table VII,	-	-	-	(6) 10 1 15
Root for 30 years, Table I,	-	-	-	(2) 45 37 30
Beginning of Chaitram and year 1554 Saca	-	-	Monday (1)	55 38 45 a leap year.

And to get to the month Vyassei ☿ (Indian May), add the Root for Chaitram,

Table III, part 2d	-	-	-	-	(2) 55 32 1
Beginning of Vyassei	-	-	-	-	Thursday (4) 51 10 46

In order to expound these, Monday, 1st Chaitram, and *Thursday*, 1st Vyassei, we find by Table V, part 2d, that the Secular year 1600 began on a *Saturday* ; and for the number of days to be added thereto, in order to get the *feria* beginning A. D. 1631, we have by Table VI, part 1, (vide Caution) for 31 years, 4. Therefore, the weekly day required was *Wednesday*, and the Domical Letter for that year E.

Now by Table V, part 2d, column 3d, it appears that the Hindu year Cali yugam 4702 (1600) began on the 6th April, and 4802 on the 8th ; therefore, referring to the Kalendar about that time, we find that *Monday*, 1st Chaitram, fell on the 7th of April ; and as the other months cannot begin earlier than the 4th or later than the 10th of their respective concurrent European months (Example II and IV), we also find that *Thursday*, 1st Vyassei, fell on the 8th of May.

But the Eclipse occurred on *Thursday* the 15th of May, which is 7 days later, therefore the notation of the Hindu Syderal time is *Gura-cara*, 8th *Vyassei*, A. Cm. 4733 and 1554 Saca, under the Meridian of and at Lanka.

OBSERVATION.

With respect to the *Civil* day registered in the Kalendar, we are to observe that as the fractional part of the Root (512 10⁷ 46^p) of the beginning of Vyassei, exceeds 30 goddesses, the Tamil month of that name must be accounted to begin, not on *Thursday*, but on *Friday* the 9th May, Civil time, which advances the notation of every day in that month by one day. Therefore,

on consulting a Kalendar which gives only the *Civil* day, should we want the *Sydecal* day on which the Eclipse really occurred, we are to subtract one day, and suppose a fraction of at least 30 guddias reckoned from Sun rise, because the 9th Viassei so registered, is only the 8th with a fraction, as has been said.

But the Hindu Patras generally predict the Eclipses for the time from *true* Sun rise, in separate articles, and independently of the *Civil* day registered in the columns of the Kalendar.

EXAMPLE IX.

There will be an Eclipse of the Sun visible in the Eastern parts of Asia, on the 11th January 1899, at 11h P. M. referred to the Meridian of Paris.—On what year, month and day, according to the Tamul Style, is it to be expected under the Meridian of Lanka? to be expressed in Solar Time (vide remark, preceding Example, page 41.)

CAUTION.

The date falling in January, the notation of the Tamul year must be $(1899-1) 1898+3102 = 5000$ Cali yugam, or $(5000-3179) 1821$ Saca, both current. (Vide Memorandum 2^o page 30), and the Rule must be worked with A. D. 1898—).

RULE.

	P.	O.	V.	K.
Epoch for 1800, Table VII,	-	-	-	(5) 54 16 13
Root for 90 years, Table I,	-	-	-	(1) 16 52 30
Do. for 7 years complete,	-	-	-	(1) 48 38 45

Beginning of Chaitram and year A. Cal. 5000 . . . Monday, (1) 59 47 30

To expound the monthly date of which, we find by Table V, that the 19th century begins on a *Wednesday*, Gregorian Style; and Table VI, part 2d, for 98 years gives 3 days to be added to the said *Wednesday*, to have the *feria* beginning the year A. D. 1898. The Dominical Letter is therefore B, and for 1899 A.

Now to expound the Hindu date, we find by Table V, part 2d, column 3d, that the year Cali yug 4902 (1800) began on the 10th April, and 5002 on the 12th, therefore 5000 must have fallen near those limits, for which reason refer to Kalendar at the Dominical Letter B about that time, and you find *Monday* the 11th April, to be the required date.

But the predicted Eclipse falls on the 11th January of the *succeeding* year, which to deduce

	P.	O.	V.	K.
To the Root of 1st Chaitram above found	-	-	-	(1) 59 47 30
Add Collective Root for Margali 4, Table III, part 3d,	-	-	-	(2) 32 35 11
You have beginning of Tye 5 th , A. Cal. 5000	-	-	-	Thursday, (4) 39 19 41

To expound this Thursday, we are to remember that as the 1st Chaitram of this Hindu year fell on the 11th April, none of the other months of the year can begin later than the 19th of its

own concurrent month (vide Example II, page 33, and IV, page 37). Therefore referring to the Kalendar with the Dominical Letter A (because *Tye* falls in January 1899) about that time, you find that 1st *Tye* falls on the 12th January of that year.

But the proposed date is the 11th January, therefore the Eclipse will occur on the last day of Margali (the preceding month), which may count 29 or 30 days.

For the resolution of this case, observing that 1st *Tye* fell on the 12th January, *n. c. v. r.*
 whose Root was (4) 39 17 41
 Subtract Root for Margali, Table III, part 2d, (1) 20 16 1

There remains beginning of Margali - - - - - Wednesday (3) 19 1 40
 which expounding with the Dominical Letter B (because we return to December 1898), about the 12th, we find this Wednesday falling on the 14th December. Hence from 31 days in

December 31

Subtract 14

There remain 17 in Dec.

Add 12 days the date of 1st *Tye* in January - - - - - 12

Number of days in Margali A. Cm. 5000 - - - - - 29 days.

Hence the 11th January must be noted *Bhuda.vara* (Wednesday), the 29th of Margali.

But the hour of the Eclipse referred to the Meridian of Paris

was 11^h P. M. which to reduce to that of *Lanca*, we have

Hour at Paris - - - - - 11 0 0 P. M.

And to count from the preceding midnight - - - - - 12 0 0

23 0 0 from midnight

Reduce to Longitude of *Lanca* from Paris, page 9, - - - - - + 4 54 12 E

In European Time - - - - - 1^h 3 54 12 from midnight

Which converted into Hindu Time gives, by Table IV, - - - - - 1 9 45 30 Do.

And to count from Sun rise - - - - - Sub. 15 0 0

There remains to be counted at *Lanca* - - - - - 0 54 45 30 from Sun rise.

ANSWER.

The predicted Eclipse of the 11th January 1899, which is to occur at 11^h P. M. Meridian of Paris, was to be expected at *Lanca*, on *Bhuda.vara*, the 29th Margali, A. Cm. 5000 or Sacn 1821, at 54 guddias, 45 riguddias, 30 paras after Sun rise or mean Solar time.

OBSERVATION.

As the fractional part of the Root for the beginning of Margali (19x 17 40p as above) falls short of 30 guddias, the Civil and Sydercal day for the whole of that month will coincide, so that the notation remains the same.

It may further be observed, that retrenching the 54^h 45^m 40^s from the ensuing Sun rise, the Eclipse will occur at Lanka on the 1st Tye, 54^h 14^m 30^s before Sun rise, so that it will not be visible at that place.

EXAMPLE X. (*)

The most ancient Eclipse which has been transmitted to us from the Babylonians, occurred on the 19th March 720 before Christ, at 6^h 48^m P. M. reduced to the Meridian of Paris.—Wanted the concurrent Hindu year, month and day, under the Meridian and Latitude of Lanka. (Vide Remark, Example VIII, p. 41.)

CAUTION.

The year 720 being dividible by 4 without a remainder, is a bissextile one, and therefore we pre-
to use the 1st part of Table VI.

The proposed date being 19th March, and Table V, part 3d, showing that the year Cali yug 3304 (700 A. C.) began on the 7th of that month, and 3404 (600 A. C.) on the 8th, there can be no doubt that the notation of the year must be (3104—720) 2382 Cali yug.

RULE.

Root for the beginning of the year 700 before Christ, Table VIII, part 3d,	(0) 55 40 0
And for 20 years, Table I,	sub. — (4) 10 25 0

Beginning of Chaitram and year Cali yug 2382 current,	Wednesday (3) 46 15 0
---	-----------------------

To expound which, we find by Table V, part 3d, that the Secular European year 700 began on a *Thursday*; and Table VI, part 1st, (the year being bissextile) for 20 years gives 4 to be sub-
tracted from Thursday, i. e. *Sunday*, for the weekly day which begins A. A. C. 720, and conse-
quently its Dominical Letters AG.

Again, by Table V, part 3d, column 6th, we find that the Hindu Solar year concurrent with A. A. C. 700, began on the 7th March, therefore referring to the Kalendar with the Letter G about that time, we find that Wednesday, 1st Chaitram, and year Cali yugam 2382, fell on the 7th March 720 A. C.

But the date proposed is the 19th of March current, or 18th complete; therefore adding 11 days to the 1st, we have *Ravi-vara* (Sunday), the 12th of Chaitram.

Now the Eclipse occurred at 6^h 48^m P. M. Meridian of Paris, which to reduce to that of Lanka, we proceed as before.

(*) This Example refers to another given in the Note for equating the Aynassu to the European Tables, given at the end of the volume.

Time of Eclipse at Paris	-	-	-	m.	'	"	
To reckon from preceding Midnight	-	-	-	5	48	0	from Noon.
				+	12	0	0
					15	48	0 from Midnight.
Add Longitude in time from Paris to Lauca	-	-	-	+	4	54	12
Time in European hours, m. & s.	-	-	-		23	42	12
							Do.
which converted into guddias, viguddias and paras, by means							
of Table IV, give					59	15	30
And to reckon from Sun rise at Lauca	-	-	-	-	15	0	0
							Do.
There remains time of Eclipse	-	-	-		44	15	30 from mean Sun rise,
Solar time.							

ANSWER.

The Hindu time concurrent to that of the Eclipse which occurred on Monday the 18th March, A. A. C. 720, at 5h 48' P. M. Paris time, is 12th Chaitram, A. Cali yugam 2352, on Ravi-vara, at 44h 15' 30p after Sun rise, Solar time, at Lauca.



PART III.

We shall now proceed to give some Examples of the converse of the proposition, which differs only in the manner of stating the question, the same Rule applying to both cases.

EXAMPLE I.

A Native applies to a Collector to farm certain lands, and wants a Potah which is to bear date the 1st Chaitram, 1748 Saca. What is the concurrent date with that epoch, according to the European Kalendar?

NOTATION:

Saca 1748 + 3179 = 4927 Call yugam,
and 4927 — 3102 = A. D. 1825, therefore 1824 is to be used in the computation.

RULE.

To find the beginning of Chaitram and year Call yugam 4927, proceed with 1825, as before, viz.

	n.	o.	r.	p.
Epoch for 1800, Table VII,	(5)	54	18	15
Root for 20 years, Table I,	(4)	10	25	0
Do. for 4 years complete, Do.	(3)	2	5	0
Beginning of Chaitram and year 1748 Saca	Monday	(1)	6	45 15
				a common year.

To expound the date of this Monday, we find by Table V, part 2d, that the Secular year Call yugam (4952) 1800, begins on a *Wednesday*, Gregorian Style; and 25 odd years, by Table VI, part 2d, gives *three* days to be added thereto, to have the weekly day beginning the year 1825; i. e. *Saturday*, and therefore the Dominical Letter for that year is B.

Now Table V, part 2d, column 3d, shews that the year Call yugam 4902 (1800) began on our 10th April N. S. and 5002 (1900) on the 12th, therefore the commencement of 4927 cannot fall later than the 13th.

Referring, therefore, to the Kalendar at the Dominical Letter B about that time, we find that the *Monday* on which the concurrent Tamul year will begin, falls on the 11th of April; we have, therefore, the following

ANSWER..

The Potah bearing date 1st Chaitram, 1748 Saca, is to run from 11th April 1825.

EXAMPLE II.

A Meraai was granted to the original proprietor on the 15th Margali (୧), A. 623 Saca, concurrent with A. Call yugam 3302. Wanted the European date thereof.

NOTATION.

3502—3102=A. D. 700, and 699 to be used in the computation.

CAUTION.

1^o Finding that the European concurrent date 700 falls considerably before the year A. D. 1582, this proposition must be expounded according to the Julian Style: therefore, part 1st of Tables V and VI, are to be used.

2^o The proposed year, beginning the century, the Root for 1 year (1st) 15 31 15 must be subtracted from the epoch given in Table VII.

3^o Margali being concurrent with the time about our December, the proposed date being 15th of the Hindu month, may possibly fall in our January 701.

RULE.

	D.	G.	V.	P.
From Root for Epoch A. D. 700, Table VII,	(0)	21	21	15
Subtract Root for 1 year, Table I,	(1)	15	31	15
By Jernal beginning A. C. 3502	Saturday	(5)	5	60 0
a common year.				
And to get to the Hindu month Margali (1), add the Root for Cariga complete,				
Table III, part 3d,	(1)	18	37	10
Beginning of Margali 3502,	Sunday	(0)	24	27 10

Now to expound the day on which these, *Saturday*, 1st Chaitram, and *Sunday*, 1st Margali, occur according to the European Kalendar, we find by Table V, part 1st, that the Secular year 700 began on a *Thursday*, and that the Tamul year concurrent therewith, began on the 20th March; therefore no further operation is required for this part of the Rule, the Dominical Letters DC being also given.

And for *Sunday*, 1st Margali, as it cannot fall earlier than the 18th or later than the 24th of November, referring to the Kalendar at the Dominical Letter C, we have *Sunday*, 21st of November.

But the proposed date is the 15th Margali, therefore adding 15 days to 21st November, we have *Monday*, 6th December.

ANSWER.

The Mirasi being dated 15th *Margali*, Anno 623 *Saca*, was granted on the 6th December A. D. 700 Julian Style.

EXAMPLE III.

A Judge is moved to grant probate of a will, which bears date 20th Paratasi (परासी) A. 1577 *Saca*.—To what Christian year and date, does this will refer? N. S.

NOTATION.

1577+3179=4756 Call yug, and 4756—3102=A. D. 1654; and 1653 is to be used.

Ruiz.

	a.	d.	t.	p.
Epoeb for 1600, Table VII,	-	-	-	-
Root for 70 years, Table I,	(6)	10	6	13
Do. for 9 years complete, Do.	(4)	6	27	30
	(4)	19	41	15
Beginning of Chaitram and year 1603 Saca	(0)	36	16	0

To expound which, Table V, part 1st, shows that the 17th century began on a *Tuesday* Julian Style, and Table VI, part 1st, that for 80 odd years, 2 days are to be added thereto, in order to have the weekly day beginning the year 1680, i. e. *Thursday*; and consequently, that the Dominical Letters for that year are DC.

Now by Table V, part 1st, column 5th, the year Cali yugam 4702, concurrent with our Secular year 1600, began on the 27th March O. S., therefore 4782 cannot begin later than the 28th. Refer therefore, to the Kalendar at the Dominical Letter C about that time, and you will find the proposed Ravi.vara (Sunday), 1st Chaitram, to fall on the 28th of March.

But the date proposed is the 9th Chaitram, i. e. 8 days later; adding therefore 8 to 28th of March, we have the following

ANSWER.

Sevagee, having died on the 9th Chaitram, A. 1603 Saca, the date of this event is to be recorded as having occurred on Monday, the 5th April 1680.



NOTE.

On the Solar year used in the Southern Provinces of India and Cycle of 60 years, called *Graha-parivartithi*, the duration of the year being 3654 95 12' 36" European time, and 3654 154 31' 30" Indian time. (*)

Not having been able to procure a copy of the *Vakya carana* (a treatise on Astronomy), in which I was told the theory of the Cycle of 60 years is explained, I have little to say on the principles of that particular division of time. I was indeed informed by the *Jyotish Sautras* of Madras, that it consisted of the sum of one Revolution of the Sun, 15 of Mars, 22 of Mercury, 11 of Jupiter, 5 of Venus, and 29 of Saturn: but probably, for want of the elements used by *Vararouchy* (the supposed author of the *Vakya carana*), I never could make the collective time due to these, amount to 328734 178 15" which is the duration of 60 years of 3654 154 31' 30" (+). But, be this as it may, there can be no doubt on the construction of the Calendar, as it is here explained. It was analyzed by Father Beschi (from one of whose manuscripts I extracted in part the substance of the present Note) during his residence of above forty years in Madras, where he was in charge of the Portuguese mission in that and adjacent provinces.

The Southern inhabitants of the Peninsula of India use a Cycle of 60 Solar years, which is little known in the Carnatic: their Astronomers call themselves *Sittandij*, or of the South, in contradistinction of their Northern neighbours, whom they call the *Vachij*, not because that word signifies that opposite point of the compass, but because they use the *Vakiam* process in their computations, of which an account will be found in the second Memoir of this collection.

	n.	d.	'	"		n.	d.	'	"
(*) The European Syderal year is	365	6	9	10	Anomalls	365	6	15	24
The Indian	365	6	12	39		365	6	15	0
Difference of the Indian	+		3	30					24

The European Tropical year being 365d. 5h 48' 45".

	n.	d.	'	"		n.	d.	'	"
Vachij	365	6	12	30	Vakya carana	365	6	12	35
Aria Siddhanta, Syderal year	365	5	48	45		365	5	48	45
European Tropical									
Difference of the Indian	+		23	45					51

(+) Having computed the above mentioned number of Revolutions of the Sun and Six Planets by the elements at my disposition, I found the time answering thereto equal to 32885d. 7g. 1v. giving a difference in excess of 11d. 52g. 46v.

The duration of the Solar year (which is Syderal) they divide and express in the following manner:

$365^d 15^h 31^v 30r = 52 \text{ weeks} + 1^d 15^h 31^v 30r = 1^d 15^h + 1^v$. Then multiplying the first member $1^d 15^h$ by 2, they have an equation, for two years, of $2^d 31^h$: which quantity they divide again into two unequal parts, viz. $1^d 16^h$, and $1^d 15^h$ (independently of the second member 1^v , of which more hereafter.)

The first equation, viz. $1^d 16^h$ they add to the odd years of the Cycle of 90, and the second $1^d 15^h$ to the even ones, beginning with the first year, with the exception of the 40th and 80th year, to which, though even, they add the first equation $1^d 16^h$.

With regard to the odd *vguddia* and half of the second term of the original equation, it is to be considered that in 40 years, this quantity amounts to one *guddia* (or Tamil hour); which they add to the 40th year, making its duration $365^d 16^h 31^v 15r$. By this contrivance the beginning of the years of the *Sittandj* agrees very nearly with that of the *Pachj*.

The epoch to which the Cycle of 90 years refers, is when 3078 years of the Cali yug had expired; answering to A. Ante Christum 24: so that if the number of Cycles and years expired since the epoch be required, "subtract 3078 from the years expired of the Cali yug, divide the remainder by 90, and the quotient gives the number of Cycles, and the remainder, the number of years expired sought."

EXAMPLE.

Let the year of the Cali yug 4846 complete, be proposed. Wanted the elapsed Cycles and years of the Parivritthi.

Epoch A. A. C. 24,
Cali yug 3078.
Precept for finding
the Cycles and years
expired of the Gra-
haparivritthi at any
given epoch.

Note.

$$\begin{array}{r}
 \text{Sey A. C. 4846} \\
 \underline{\quad 3078 \quad} \\
 90)1768(19 \\
 \underline{90} \\
 868 \\
 \underline{810} \\
 58
 \end{array}$$

Remainder 58

which shows that on the year sought there were 19 Cycles and 58 years of the *zera* expired; and therefore, that the current ones were the 20th Cycle and 52th year.

We may operate on the same principle if the Christian year be proposed, by reversing the process.

EXAMPLE II.

Let A. D. 1745 (Cali yug 4846 complete) be proposed; to find the Cycle and year of the *Grahaparivritthi*.

$$\begin{array}{r}
 15 \\
 1745 \\
 - 1 \\
 \hline
 1744 \\
 + 24 \\
 \hline
 1768
 \end{array}$$

$$\begin{array}{r}
 20 \\
 90)1768(19 \\
 \underline{180} \\
 268 \\
 \underline{810} \\
 58
 \end{array}$$

1768. The same result as in the preceding Example.

On the construction of the year, and of Table II.

The *Ahargana* of the *Sittandij* on the beginning of the Solar year 3102, which occurred (according to their account) on Saturday the 13th March

A. D. 1 is 1132053 24 50 13

Now if to that sum you add for 1701 of their own years, 621303 9 9 15

The *Ahargana* for the Solar year, which ended on Saturday 7)1753570(4 0 0

29th March O. S. will be 1753370d 4g, and in order to count from Sunday, instead of Friday, the Root of the same

must be expressed by (64) 4g, as was explained at pages 9.

and 10; and as appears at the head of Table II as the epoch.

for A. D. 1700, which quantity they call *Atchâ*.

For finding the circumstances of any proposed year the commencement of which has been determined, the Rule is exactly the same as that which has been explained in the Memoir on the Tamul year, the only difference being in the duration of the months, which is very trifling. It is given here merely because it represents those of the *Surriah Siddhanta*, within a *para* of time on the whole year.

Construction of the year and of Table II.

Remainder 1 from Friday
Soola dina Saturday.

(*)

Atchâ, an epoch to which computations are referred.

Rule for the months.

		Names Surriah Siddhanta.	Names Tamula.	Sydereal duration of each month.				Separate Roots.				Collective Roots.			
				n.	g.	r.	p.	n.	g.	r.	p.	n.	g.	r.	p.
γ	1	Môsha masa	Chaitram	30	55	32	3	(2)	55	32	3	(2)	55	32	3
δ	2	Vrîsha masa	Vaisak	31	24	12	4	(3)	24	12	4	(6)	19	44	7
Π	3	Mid'huna masa	Auni	31	36	38	4	(1)	36	38	4	(2)	56	22	11
Σ	4	Carçâta masa	Audi	31	28	12	4	(3)	28	12	4	(6)	24	34	15
Ω	5	Tisha masa	Aurani	31	2	10	3	(3)	12	10	3	(2)	26	44	18
⋈	6	Canyâ masa	Paratsâi	30	27	22	3	(2)	27	22	3	(4)	54	6	21
♊	7	Tula masa	Arpest	29	54	7	2	(1)	54	7	2	(6)	48	13	23
♋	8	Vrîschica masa	Cartiga	29	30	24	1	(1)	30	24	1	(1)	19	37	24
♌	9	Dhanus masa	Margali	29	20	23	1	(1)	20	23	1	(2)	39	30	25
♍	10	Macara masa	Tye	29	27	16	1	(1)	27	16	1	(4)	6	46	26
♎	11	Gumbha masa	Maussi	29	48	24	2	(1)	48	24	2	(5)	55	10	28
♏	12	Min masa	Poongoni	30	20	21	2	(2)	20	21	2	(1)	15	31	30

(*) The *Ahargana* of the *Yochij* is 1132053d. 1g. 15v., and according to their account the Solar year 3102 began on Sunday the 14th March A. D. 1. But it may be perceived that in reality there is but 8g. 24v. 15p. difference; the fraction of days of the greater sum, being 1g., and of the lesser 5g.

There remains now only to explain how the rest of Table II was constructed.

For the Cycles.

To the Atchâ, or Epoch above found	-	-	-	-	n.	a.
Add for 90 years	-	-	-	-	(6)	4
					(1)	15
Root for the second Cycle	-	-	-	-	(0)	19
Add for all succeeding Cycles add	-	-	-	-	(1)	17
3d Cycle	-	-	-	-	(4)	36
					(3)	17
4th Cycle	-	-	-	-	(2)	53
					&c.	

For the odd years of the Cycles.

The Roots of the odd years of the Cycles are obtained by adding (1^d) 14g to the odd and (1^d) 15g to the even ones, excepting the 40th and 80th, to which, altho' even ones, (1^d) 16g instead of (1^d) 15g are to be added, for the reasons explained at page 52.

The difference of two guddias (1^d) 15g added to the Atchâ of the first for obtaining the Root of the second Cycle less than, for the rest is probably a *Sodium*, or constant quantity subtracted from the result, to fit a particular epoch, which we would term an *Empirical equation*, the same being called *Cshepu* when additive; at least I have not been able to discover on what theory the difference is established.

Rules for finding the beginnings of the years by Table II.

How to find the beginning of the year by the Tables.

In order to find the commencement of any proposed year by this Table, we must first find the number of Cycles and years expired from the beginning of the Cali yug; then take particular notice whether the remainder indicates an odd or even year; and lastly, whether it be the 40th, or 80th of the Cycle.

After summing up the Roots for the Cycles (column 1) and for the year (column 2), you are to add 31 viguddias in even, and subtract 29 in odd years, excepting the 40th and 80th of the Cycle, which require (though these be even ones) that 29 guddias be subtracted from the sum.

How to find by Table II the commencement of the Solar year of the Cycle of 90.

Let the year of the Cali yug 4847 current or 4846 complete, be proposed, and its beginning required.

1 ^o From	4846	
Subtract	3102	
Christian year to be used in the computation	1744	
2 ^o 50) 1744 19		
31		
add 24	or by the Hindu account	4846
25		3078
		1768
	19 Cycles, 58 years.	90) 1768 (19
		368
		and 58

3 ^a . Referring at 19 to the column of Cycles in Table II, we have	10 ^e	n.	d.	v.	r.
And at 55 in the column of years	55 ^r	(2)	25		
	6	(6)	55		
		(3)	4		

And on account of the year being even					(5) 25
					add + 0 31
					Friday (5) 25 31 0
The same according to the Vachij					(5) 25 0 13
					Difference 24 43

The rest of the operation is in every respect similar to that employed in the resolution of the beginning of the Tamil year; the *Vachij* and *Sittandij* counting the Civil and Syderal duration of the years and months in the same manner.

The Rules of the Northern and Southern Tamil Astronomers compared.

I shall conclude this exposition of the method of the Southern Astronomers, by giving some Rules for comparing its results with those of the Northern account, to facilitate which, I shall present the two Rules simultaneously expounded.

EXAMPLE I.

Let the 1st year current of the 1st Cycle current, be proposed: wanted the time of its beginning, by both Rules.

CAUTION.

1^a. The year 0, of Cycle 0 of the Epoch of the Sittandij, corresponds to A. Ante Christum 24 and to that of the Caliyug 3078.

2^a. The year is an even one.

Sittandij.			Vachij.		
	n.	d.		n.	d.
For 0 Cycle, Table II,	(6)	4	By Table VIII, A. A. C. for 20 years	(4)	5 21 15
For 0 year, part 2d	(0)	0	By Table I, for 4 years complete	(5)	2 5 0
	(6)	4		(6)	4 15 0
The year being an even one, add		31	Sittandij	(6)	4 31 0
Root of beginning	(6)	4 31	Difference Sittandij, +		14 43

EXAMPLE II.

Let the 41st year current of the 1st Cycle current, or 40th year complete of Cycle 0, be proposed: proceeding as before, this year will be found to correspond to A. D. 17.

CAUTION.

As 17—1=16 is to be used, this is an even year; but it is the 40th of the Cycle (vide page 52).

RULE.

Sittandij.	n. o. v.	Vachij.	n. o. v. e.
By Table II, part 1st, 0 Cycle	(6) 4	Table VIII, A. D. 0	(1) 16 46 15
Do. part 2d, 40 years	(1) 21	Table I, 10 years	(5) 35 12 30
	(0) 25	Do. 6 years	(0) 33 7 30
But the year is the 40th of the Cycle, therefore subtract	(0) 0 29	Sittandij	(0) 25 6 15
	(0) 24 31	Difference Sittandij	(0) 24 31 0
			33 15

EXAMPLE III.

Let the 46th year current of the 6th Cycle current, or 45th complete year of the 5th Cycle complete, be proposed. This year will be found to correspond to A. D. 472, and therefore $472-1=471$ is to be used.

CAUTION.

This year is an odd one, therefore 29^r are to be subtracted.

RULE.

Sittandij.	n. o. v.	Vachij.	n. o. v. e.
Table II, part 1st, 5 Cycles	(5) 27	Table VIII, A. D. 0	(1) 16 46 15
Do. part 2d, 40 years	(1) 21	Table I, 400 years	(6) 28 20 0
Do. 5 years	(5) 18	Do. 70	(4) 6 27 30
	(0) 6	Do. 1	(1) 16 31 15
But the year is an odd one, therefore subtract	29	Sittandij	(6) 7 5 0
	(6) 5 31	Difference Sittandij	(6) 5 31 0
			1 34 0

EXAMPLE IV.

Let the 31st year current of the 20th Cycle current, or 80th complete of the 19th complete, be proposed, it will answer to A. D. 1767; and as 1766 is to be used, it is an even one.

RULE.

Sittandij.	n. o. v.	Vachij.	n. o. v. e.
By Table II, part 1st, 19 Cycles	(2) 25	Table I, Epoch 1700	(5) 2 11 15
Do. 2d, 80 years	(2) 42	Do. for 60 years	(3) 31 15 0
	(5) 7	Do. 6 years	(0) 33 7 30
But this year is the 80th of the Cycle, therefore subtract	29	Sittandij	(5) 6 33 45
	(5) 6 31	Difference Sittandij	(5) 6 31 0
			2 45

It will be perceived that the greatest difference between the Northern and Southern account falls on A. Cal. 3574, or A. D. 472, being 18 34^r.

SECOND MEMOIR.

A KEY TO THE SIDDHANTA CHANDRA MANA

OR

HINDU LUNI-SOLAR YEAR,

PRINCIPALLY USED BY THE

INHABITANTS OF TELLINGANA, OR THE NORTHERN CIRCARS.

Written in the years 1823 and 1824.

THE UNIVERSITY

— 1884 —

The University of the State of New York, created by the People's Will, and established by the Legislature, has the honor to announce that it has received from the State of New York, the sum of \$1,000,000, for the purpose of purchasing the land and buildings, and for the purpose of erecting a new building, for the use of the University.

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ADVERTISEMENT.



On entering into the consideration of a method of dividing and recording time unlike any that ever was devised by man in ancient or modern times, the best warning that can be given to the reader is, to spare his attention by discarding all speculative matter, and to lead him speedily through a regular exposition of the doctrines on which that system is founded. I shall, therefore, offer but a few words by way of preface to this second Memoir, and these merely to prevent the reader from falling into the same misconceptions as I entertained when I began the present research.

It was imagined by some learned commentators, that the Hindu Astronomical Luni-solar year might be the same as some of those used by the ancients; and doubts immediately arose from that supposition, whether the Babylonians, Egyptians or Indians were the original inventors? To which I shall reply that, although certain features of resemblance may be discovered, yet neither the Mundane era and year of the Jews, nor the Chaldean *Saros*, or *Seros* (of which we know very little) have more to do with the Siddhanta *Chandra mana*, than any like division of time, where it was attempted to take into consideration and combine the Sun and Moon's revolutions.

The Luni-solar year of the ancients best known to us, reckoned that 99 Lunar months contained 2923 days and 12 hours; which in 60 years, gave an excess over the Sun's mean motion, of 3 days, and of 30 days in 160 years; on which account they omitted one of the intercalary months. This period being one of the three (viz. 12, 144 and 160 years) when the Hindus seem also to expunge a Lunar month, I was led, with other speculators, to suppose that the operation might be the same: but it soon appeared manifest to me from the present research, that the Hindus really expunge nothing, since it is only when a double intercalation is called for on their principles, that some other month is left out, so that when this case occurs, the year remains (as in all Embolismic years) one of 13 months, the only difference being, that the intercalation falls out of its usual place.

In the same manner, the order of the common intercalations during the Cycle of Meton appeared accidentally (from hitting on a particular period) to be the same as that of the Hindus; for the ancients divided their Cycle of 19 years into 12 complete and 7 incomplete years, which last they

intercalated so that their equations fell on the 3d, 6th, 8th, 11th, 14th, 17th, and 19th, as was the practice of the Jews; and there are truly periods when the Hindu intercalations follow the same course.

But on looking deeper into the subject I found, that the series in the Hindu Cycle was in a constant state of fluctuation; for on tracing the successive intercalations, according to Indian principles, from the origin of the Cali yug, I found that they ran successively through every possible change, as may be seen in the marginal note (*), a circumstance which is the necessary consequence of a system according to which nature is always suffered to follow its own course, and in which the intercalations bear only on the *names* of the months, and the length of the artificial year, without the least quantity being thrown in to fit the lesser divisions of time to the system.

The same thing may be said of the luni-solar days called *Tidhis*, these being likewise liable in *appearance* to intercalations and omissions, but not so in reality: for these circumstances depend entirely on the manner of coupling them with the corresponding solar days.

The truth is, that the Hindu Mathematicians seem, of all others that have existed, to be those who have shewn the greatest aversion to arbitrary equations; for although in our still imperfect knowledge of their Astronomy, the Hindu system appears not to be wholly free from empiricism, yet, as far as we are able to judge, the spurious quantities which we are unable to account for, may have been thrown in by them, less from choice than from necessity.

The adherence of the Hindus to that singular species of days which they call *Tidhis*, so unavailing to the purposes of civil life, is a striking proof, (among many others) of their attachment to ancient usages, for if on one hand it must be admitted, that without the use of these *Tidhis* their whole system of Astronomy must fall to the ground, on the other, as their beginning or end cannot be known without looking into the *Panchangum*, (because each may begin or end at any instant of the Solar day), it is difficult to conceive the cause which has

(*) Series of Intercalations in the Hindu Cycle of 19 years from the year 0 to 770 of the Cali yug.

From A. Cal. 0 to,

Years.	Months.	Days.	Grd.	Viz.	Revolu- tions.	Series of Intercalations.
127	10	7	41	55) 7×19	1	0 3 6 9 11 14 17 19
316	8	21	56	25) 13×19	6	0 3 6 8 11 14 17 19
539	6	21	35	45) 21×19	8	0 3 6 9 11 14 16 19
512	5	6	20	15) 27×19	6	0 3 5 8 11 14 16 19
615	3	13	32	10) 31×19	7	0 3 5 8 11 14 16 19
770	1	20	44	5) 41×19	7	0 2 5 8 11 13 16 19
						0 2 5 8 10 13 16 19

Therefore in 770 years, the series of intercalations was interrupted 8 times.

preserved their notation during so many ages in their rustic Kalendars, unless it be ascribed to their predilection for Astrology.

In truth the Tidhi is now almost entirely banished from public business, excepting in that part of India which was formerly called *Tellingana*, better known to Europeans under the name of the *Northern Circars*. But neither the testimony of the senses, nor the language of reason, could ever remove it from the moral and even physical concerns of the Indians, all believing alike, without distinction of castes or persuasions (*), that every contingency of life is ruled by the joint operation of the great luminaries of nature.—In all that relates to health, fortune, advancement, prosperity, or their contraries, the *Panchangum* must previously be consulted; but the ruling order of the Brahmins rigorously require from those among them who are qualified for, and willing to compute it, that they will scrupulously adhere to those sacred doctrines according to which the beginning and duration of the Tidhi is determined, a period, however, (it must be owned) which is no further imaginary than because it is manifested to the senses by no visible operation of nature, though it be as truly an assignable portion of time, as the Solar day is an assignable part of the Sun's tropical revolutions.

(*) In the year 1800 the Author was Member of a Court Martial which had been assembled at Nundidroog for the purpose of trying a Mahomedan Sirdar of Rank named Hyder Beg, on an accusation of high treason.—This man was honorably acquitted, and after the sentence had been confirmed, the President of the Court proceeded to the place of his confinement to announce him his deliverance.—Hyder Beg received this communication with calm gratitude, but asked leave to remain in his prison until his family might arrive to be present at his liberation, which was granted.—Two days afterwards his principal wives and children reached Nundidroog in expectation of an immediate interview; but during that interval a Brahmin Astrologer had got access to the Prisoner (himself a Mogul) and assured him that according to the *Panchangum* the Tidhi was an unlucky one, and that if he were to meet any of those who were dear to him pending its duration, they would feel the evil consequences ever after. Hyder Beg, though a grave and sensible old man, submitted to the imposition, and waited patiently until the end of the fatal Tidhi, for receiving to his bosom those dear objects whom, during the course of his trial, he had often thought he should see no more.



KEY TO THE SIDDHANTA CHANDRA MANA.

PART I.

ARTICLE 1.

ALTHOUGH there are short methods for computing the elements which are required for the construction of the Luni-solar Kalendar of the Telingas (as it is improperly called in Madras) consistently with the doctrines of the Surriah Siddhanta, yet as these give no distinct view of the theories from which they are derived, I shall begin by computing each in Sydereal time according to the Rules of the Sastras, and show afterwards and in separate articles, how the same may be obtained by different processes.

As the division of time we are about to treat of is not a *Lunar*, but a *Luni-solar* year, the Solar Kalendar for that which it may be proposed to expound, must first be constructed, at least to a certain extent, according to the Rules delivered in the Key to the Madhyama Saura mana; such a document being indispensable at every step of the problem under consideration. The construction of the leading points of the *Ravi Panchangum* requires no considerable waste of time nor labour, and may be framed, by help of the Tables given at the end of the Memoirs, in the course of a few minutes, care being taken to use those which are constructed with the elements of the Surriah Siddhanta.

There are also certain quantities and expressions which are constantly required in the process, and which it is important not to mistake: Such are the names of the Hindu Signs of the Zodiac, with their numerical succession, both current and complete; the absolute number of days which the Sun takes to move through each Sign, the number of complete natural days in each Solar month, both Civil and Sydereal; and lastly, the numbers which are to be added to the Solar, or Luni-solar *Alarganas* on the beginning of the proposed year, for obtaining the Epochs of recurrence of mean conjunctions during the whole of its duration.

My intention being to expound every case of variation to which the Luni-solar year is subject, I have selected for exemplification the year 4924 current of the Cali yug, or 1745 from the birth of Salivahana, corresponding mainly with A. D. 1822; that on which Mr. Davis has announced there would be a *Ushaya*, or expunged month, and which exhibits consequently all the changes that are to occupy our attention. I annex the Skeleton of the Chandra Panchangum for that year, in order to familiarize the reader at an early period with its singular appearance.

As every means are given in the first Memoir for ascertaining the Solar date of any Epoch proposed in European time and vice versa, and as in the present tract I shall show that the *Tidhi* cannot be expounded without a knowledge of the corresponding Solar date, both of which are always inserted in the Chandra Panchangum, it would be useless to enter again into an explanation of the process by means of which the dates expressed in one style are to be converted into another, but the operation will be performed without comments, whenever it may be required.

Quantities required for the computation of the *Luni-solar Kalendār*
for the same year.

Skeleton of the Solar Kalendār for the year Caliyugam 4924, and
Saka 1745 current (A. D. 1822.)

Years current.	Number of Lunations.	Collective number of days in Lunations.	Collective number of days of Solar months.	Names of Luni- solar months.	Names of Solar months.	Roots of begin- nings of months.	Days beginning of month	Names of Zodiacal Signs.	Days beginning of month	Beginning of month English date.
4923	0	D. S. Y. P. 0 0 0 0	D. S. Y. P. 355 15 31 31 24	Chaitra.	Poongoni	Roots D. S. Y. P. (2) 22 17 4 36		Mla	12	11 12 March
4924	Lunations									
	1	29 51 50 7	30 55 32 4 39	Vaisācha	Chaitram	(4) 42 38 7 19	30	Māsha	1	0 11 April
	2	59 3 40 14	62 19 44 5 20	Jyāishṭha	Vyāsaśi	(0) 23 10 7 31	31	Vriśāha	2	1 17 May
	3	88 24 30 21	93 55 22 8 4	Aśvādha	Audi	(4) 3 22 12 32	32	Mithūna	3	2 12 June
	4	118 7 30 28	125 24 34 10 46	Śrāvaṇa	Audi	(0) 39 0 15 19	31	Carṇāṭa	4	3 14 July
	5	147 39 10 35	156 26 44 13 29	Īśāḍra	Aurāṇi	(3) 7 12 17 55	32	Siṅha	5	4 16 Aug.
	6	177 11 0 42	186 34 6 16 4	Asvīna	Pūrtaśi	(0) 9 22 50 38	31	Canṇā	6	5 13 Sept.
	7	206 42 50 49	216 48 13 18 39	Nā'asvina	Arpasi	(2) 36 44 23 16	30	Tula	7	6 15 Oct.
	8	236 14 40 56	246 18 37 21 12	Carṇika	Carṇiga	(4) 30 31 25 51	30	Vriśācha	8	7 14 Nov.
	9	265 45 31 2	275 39 50 23 43	Mārgasīra	Mārgaśi	(0) 1 15 28 24	30	Dhānu	9	8 14 Dec.
	10	295 18 21 10	305 6 46 25 16	Pauṣṭhā	Tye	(0) 22 8 50 53	29	Makara	10	9 12 Jan.
	11	324 50 11 17	334 55 10 38 48	Phālguna	Māsasi	(1) 40 24 33 23	29	Camṭha	11	10 10 Feb.
	12	354 22 1 24	365 15 31 31 24	Chaitra or Phalguna Mitter	Poongoni	(3) 27 48 35 58	30	Mla	12	11 12 March
4925	13	383 53 51 31	395 34 4 39	Nā' Chaitra	Chaitram	(5) 58 9 38 34	30	Māsha	1	0 11 April

How to find the Solar Aharṇana for the 1st Chaitram of the year 4924 of the Caliyug, by means of Table XLVIII according to the Sarnish Siddhanta.

Part 3, Columns 3 and 4, for 4000	Ys.	As.	S.	Y.	P.	P.
do.	1401035	1	23	20	0	0
Columns 1 and 2	500	528732	53	31	0	0
do.	20	7305	10	30	28	0
do.	3	1095	45	24	34	12
Sodhyam or Equation	1798168	51	29	23	12	
	—	2	8	51	15	0
Aharṇana 1st Chaitram 4924	1798165	42	28	7	12	
Subtract absolute duration of Poongoni	—	30	20	21	2	30
Aharṇana 1st Poongoni 4924	1798136	22	17	4	36	

Divide each Aharṇana by 7) 179816255850 weeks

For Chaitram 4924 remainder 6, which counted from Friday gives Thursday, which according to Tabular expression counting from Sunday is to be noted (40) 43x 38x 7x 12x as above.

7) 1798136x 255870 weeks

Remainder 4, which counted from Friday gives Tuesday; and according to Tabular expression counting from Sunday is to be noted (24) 23x 17x 4x 35x as above.

Constant Quantities required for the Construction of the Calendar of any Luni-solar year.

	Name of Solar months.	Absolute number of days in each Solar month.	Separate Roots of do.	Collective Roots of do.	European months N. S.
		d. o. v. p. s.	Roots. d. v. p. s.	Roots. d. v. p. s.	
1	Chaitram	30 55 32 2 39	(2) 55 32 2 39	(2) 55 32 2 39	April
2	Vyasaui	31 24 12 2 41	(3) 24 12 2 41	(6) 10 44 5 20	May
3	Auni	31 56 38 2 44	(3) 56 38 2 44	(2) 56 38 2 44	June
4	Audi	31 28 12 2 42	(3) 28 12 2 42	(6) 24 34 10 46	July
5	Aurani	31 2 10 2 40	(3) 2 10 2 40	(2) 26 44 13 26	August
6	Parvati	30 27 22 2 38	(2) 27 22 2 38	(4) 54 6 16 4	September
7	Asvini	29 54 7 2 35	(1) 54 7 2 35	(6) 48 13 18 29	October
8	Cartiga	29 30 24 2 33	(1) 30 24 2 33	(1) 18 37 21 12	November
9	Margasi	29 20 53 2 31	(1) 20 53 2 31	(2) 30 30 23 43	December
10	Tya	29 27 16 2 29	(1) 27 16 2 29	(4) 6 46 26 15	January
11	Mansi	29 48 24 2 33	(1) 48 24 2 33	(5) 55 10 28 48	February
12	Poonigoni	30 20 21 2 36	(2) 20 21 2 36	(1) 15 31 31 24	March

The Roots between parentheses to be counted from Sunday : But those given in the present Table being *absolute*, are never expounded but when combined with the initial Root of the proposed year. Vide marginal note of Table III (Madhyama Saura Mana),—the only difference being in the quantities, which in that Table are derived from the Elements of the Ariah Siddhanta.

[illegible]

ARTICLE 2.

General account of the Siddhanta Panchangam.

The Lunar-solar year under consideration is accounted to begin at the true instant of conjunction, or new Moon, which precedes the commencement of the Solar year, with which it is mainly to concur; and is to be distinguished from the *Bhava Husputtia mana*, which commences with the full Moon which precedes the same, the months of the former being termed *Matsya*, or primary; those of the latter, *Gauna*, or secondary. The *Bhava Husputtia mana* is not used in these parts of India.

The *Chandra Mana* is divided into twelve months, subject by intercalation to a thirteenth month, each, whatever be its real duration, being divided into 30 *Tidhis*.

Names of the Lunar months.

1	Chaitra	5	Srawana	9	{ Margashira or Agrahayana	Names of the Lunar months.
2	Vaisacha	6	Bha'drapada	10	Pausia	
3	Jyeshtha	7	Aswina	11	Magha	
4	A'sha'd'ha	8	Cartiga	12	Phalguna.	

The month is divided into two parts of 15 *Tidhis* each, called *Pachsa* or *Pachum*, the first fortnight being denominated *Sukla* or *Soocha* (the enlightened), the second *Christna* or *Bakoola* (the dark) half of the month. A *Pachsa* 15 *Tidhis*.

Names and duration of the Solar months, (Surreish Siddhanta.)

	Bengal.	Tamil.		Absolute duration of each.					The same collectively.					Names and duration of the Solar months.
				B.	C.	V.	F.	S.	B.	C.	V.	F.	S.	
1	Vaisa'cha	Chaitram	γ	30	55	32	2	39	30	55	32	2	39	
2	Jyeshtha	Vyasaai	δ	31	24	12	3	41	62	19	44	5	20	
3	A'sha'd'ha	Audi	II	31	38	38	2	44	93	56	22	8	4	
4	Sra'wana	Audi	⊙	31	28	12	2	42	125	24	34	10	46	
5	Bha'drapada	Auvani	Ω	31	2	10	2	40	156	25	44	13	26	
6	A'swina	Paravani	⊙	30	27	22	2	38	186	54	6	16	4	
7	Ca'rtiga	Arpasi	△	29	54	7	2	35	215	48	15	18	39	
8	Ma'rgasi'ras	Cartiga	III	29	30	24	2	33	245	18	37	21	12	
9	Pausia	Margasi	†	29	20	53	2	31	275	50	30	23	43	
10	Ma'gha	Tye	∇	29	27	16	2	32	305	6	46	26	15	
11	Pha'lguna	Maursi	=	29	48	24	2	33	334	55	10	28	48	
12	Chaitra	Poongoni	⋈	30	20	21	2	35	365	13	31	31	29	

The duration of these months, which is derived from the elements of the Sarrink Siddhanta, and is that used by Tellinga Astronomers, differs from that which proceeds from those of the Arish Siddhanta only in the ratio of $\frac{173}{110} \frac{13}{43} \frac{33}{24} \frac{21}{11} \frac{11}{12}$. The Tamul Astronomers, however, prefer the latter, even in their Lunar computations; and on that account the Solar Abasana given in the General Table II, was computed with the Solar year of 365 $\frac{1}{4}$ 13 $\frac{1}{2}$ 31 $\frac{1}{2}$ 13p.

The instant of true conjunction which determines the commencement of the month is called *Arca-Indoo-Sanyama*, literally meaning conjunction of the Sun and Moon. It is also called *Duroham*, but more generally *Amavasya*.

Amavasya Tidhi,
Day of conjunction,

Although the instant of conjunction be that which determines the commencement of the year or month, yet the day on which it occurs, and which on that account is called the *Amavasya* Tidhi, is always reckoned in the Kalendar, as well as in account, as the 30th Tidhi of the Lunar month, because it ends on that instant. The *Pratham* or first Tidhi of the ensuing month is always accounted to be the next, for the same reason.

Purnima Tidhi,
Day of opposition,

The day of opposition is called Purnima Tidhi, and is always the 15th of the East Pancha (*).

The names of each Tidhi in each Pancha or fortnight, are as follows:

Names of the days
of the Pancha,

1	Padyami	6	Shusti	11	Yamadai
2	Vidya or Daitia	7	Saptami	12	Dundhai
3	Tadya	8	Ashtami	13	Tryadasi
4	Chonti	9	Navami	14	Chaturdasi
5	Panchami	10	Desami	15	Purnami

These names, which are merely neutrals, will probably strike the reader, from their frequent resemblance to Latin words of the same import.

In the Panchangam the days are numbered no farther than fifteen, but in computations the series is followed up to thirty. It is, however, customary in numbering the last Pancha in the Kalendar, to mark the 15th or last Tidhi (Purnami) the 30th, although the preceding one be noted the 14th and sometimes the 13th, unless the said 30th or Amavasya Tidhi should happen to be a *Cahaya* or expunged day; in which, and similar cases, it would be left out of the column, and (together with its duration) noted in the margin. The last day of the month when this occurs is registered the 14th; as was the case in the month of Vaisakha of the year 1921 (†) current.

Although the Cycle of 60 years (Vrishaspati) has no immediate reference to the Chaulra

(*) The Tamils, and generally the Natives on the Coast, where their language is prevalent, with few exceptions, pronounce very badly all these names; and when they write them in English, it is difficult to recognize them. I have followed Dr. William Jones, Mr. Davis and Mr. Scott's orthography, and I think it desirable that it should be maintained.

(†) Tide Kalendar, page 67.

Mana, yet I find in an old manuscript in my possession, that the Southern Astronomers use it for obtaining the Ahergana (*). The practice, however, not being general; I barely mention it. But it is customary every where to annex the name of the concurrent Vrihaspati year to the proposed Ciandra Mana. (†)

This, and other practices, lengthen considerably the common manner of dating letters and other documents, for if an inhabitant of the country which is still sometimes called Tellingana, wishes to be very precise in dating a letter or bill of exchange, which let it be the 2^d Tithi of the intercalary month Aswina of the Lunar-solar year Cali yugam 4924; his notation will be as follows:

“Chitrabhandu smrat saram; Adigah Aswina; Suddha Dvitya, Mangala-vara, Cali yugam 4924; Saca 1745.”

ANALYSIS.

In the year Chitrabhandu (the 16th of the Cycle of 60 Tellingana account)—of the intercalary month Aswina the 2^d day,—Tuesday; A^o Cali yugam 4924, and Saca 1745.

I am informed that this style in ancient times generally prevailed in all Tellingana; not only for private, but for public transactions. In latter times, however, it was found so extremely inconvenient (particularly since the introduction of the British power), that it was banished from all cutcherries, and the Solar Calendar became that of the state. It is, however, still retained by the Brahmans, and most merchants at Masulipatam, Vizagapatam, Ganjam, and other places in the Northern Circars.

The following terms and definitions require particular attention.

- 1^o When the year is a common one, it is called by the general name of *Samvat saram*, or *saram*.
- 2^o An intercalary year.—*Adigah Samvat saram*.
- 3^o A double intercalary year, and consequently affected with an expunged month.—*Cahaya Samvat saram*.
- 4^o When a month is intercalated, the word *Adigah* is prefixed to it (meaning added). Thus

Manner of dating.

Manner of dating in Tellingana.

The Solar Calendar, that for public business.

Samvat saram, name of a common year.

Adigah Samvat saram, an intercalary year.

Cahaya Samvat saram, a double intercalary year with an expunged month.

(*) What follows is a literal translation of the article referred to.

“Three things are requisite for determining the time of an Eclipse, viz. 1st The Soots dina, or the End of the number of days which have elapsed since the Epoch fixed upon by the Author of the Rule. Now this Epoch falls on the 12th year of the Indian Cycle of 60 years; and there are elapsed (so it is supposed) 40 of these Cycles until the year 1747, when the Cycle began anew. So multiplying 60 by 40, and adding 48 years to the product (48 years remaining of the first Cycle), you have the number of years that have passed up to the year 1747. Moreover, multiply the total sum by 243 days, 15 naitins, 31 vinsad (the Taxul wages for goddins and viggodins) and 13 tarparys (purns); add thereto the number of months, days, minutes, &c. elapsed since the Astronomical or true beginning of the current year, and you have the precise day sought, &c. &c.”

(†) These names are inserted in the General Table I given at the end of the Tables.

Adigah Arwina "intercalated *Arwina*" and *Nija* (or proper) to the second, repeating the name of the month.

5^o In the case of two intercalations in the same year, Tellinga Astronomers call indistinctly the second intercalation by the name of the month which occasions it, or by that of the preceding month: adding *adik* to it. Thus in the *Patra* for the year 4934 the last *Adigah* may either be called, *Adigah Chitra*, or *Phalgun* - *adik*.

6^o When an expunged month occurs, the name of that on which it falls is coupled with that which follows it; and the second is the month proper. Thus in the said year 4934, the expunged month falling on *Margashira* (Agrayan); the notation is *Margashira Pausya*; and the latter is the proper current month.

7^o When two *Tidhis* end in a concurrent Solar day, the intermediate *Tidhi* is expunged out of the column of days in the Kalendar, and it is called a *Cahaya Tidhi*. The numerical series is therefore interrupted; but the omitted *Tidhi*, together with its duration, are registered in the margin. Thus we have in the month *Cartiga* (first *Pachum*) 11, 12, *, 14, 15, the 13th being registered out of the line as a *Cahaya*.

8^o When no *Tidhi* begins or ends in a Solar day, the preceding is an *Adigah*, or intercalary day, and its numeral is repeated. Thus we have in the first *Pachum* of *Vaisacha*, 13, 14, *, 14, 15. The first *Tidhi* being accounted the intercalated, and the second the proper one.

9^o When a *Tidhi* is found to begin "before Sun-rise, or at Sun-rise" then it is accounted to belong to its concurrent Solar day.

10^o When a *Tidhi* is found to begin "after Sun-rise," then it is taken to belong to the ensuing Solar day, "provided it does not end in the same day," because in such a case it would fall within the operation of article 7^o, and would be expunged out of the column of *Tidhis*.

11^o If a *Tidhi* be expunged, it is sometimes called *Avamaha*, or *Oopadi*, which means advanced. This circumstance happens on a medium, once in 64 days; so that in one year it recurs five or six times.

12^o When a *Tidhi* is repeated twice, it is sometimes called *Triulna*, or *Sprookoo*; the most common designations however, are *Cahaya* for expunged; and *Adigah* for intercalated.

13^o In the language of Tellinga Astronomers a *Tidhi* is a Luni-solar day; and a *Theidi*, a Solar day; a notation which it is necessary to remember when reading Hindu tracts, to avoid mistakes. *Theidi* means also a date.

14^o From the preceding articles it will be easily perceived that the introduction or omission of a *Tidhi* in the columns of the Kalendar, is purely nominal, which proposition may be illustrated in the following manner.



Two *Tidhis* ending in a Solar day, the intermediate a *Cahaya*.

No *Tidhi* beginning or ending in the same Solar day as *Adigah*.

A *Tidhi* beginning before Sun rise or at Sun rise belongs to the concurrent Solar day.

A *Tidhi* beginning after Sun rise belongs to the ensuing Solar day.

The intercalary and expunged *Tidhis* purely nominal.

Let TT' and $T'T'$ represent two Tiddis; and DD' , $D'D'$ two concurrent Solar days, then as T (14th) began *before Sun-rise*, it belongs to the 24th Vyassati (Solar Kalendar); but as T' began *after Sun-rise*, it belongs not to the 25th, but to the 26th Vyassati (articles 2^a and 10^a), and so the 25th remains seemingly without an appropriate Tiddi. Hence it comes to pass that the preceding Lunar Tiddi (14th) is supposed to go on until the 26th Vyassati, whose concurrent Tiddi is therefore noted the 15th; and so forth for every possible case.

A constant recollection of this singular disposition, is indispensable to the clear understanding of the manner of registering the days and Tiddis in the Kalendar; and what renders it the more perplexed is, that although the Tiddis are computed according to *apparent time*, yet they are registered in *civil time*.

The Tiddis computed according to *sydereal time* registered in *Civil account*.

The precise instant of the day after Sun rise in which the Tiddi ends, is the first article inserted in the margin opposite to it.

ARTICLE 2.

Independently of the preceding articles, the Ephemerides which always accompany the Pauchangams, exhibit several others, five of which are given for every day, and the rest as there is occasion—the five principal ones are as follows:

Articles of the Ephemerides annexed to the Pauchangam.

1^o The *Nacshatra* in which the Moon is on the given day. 2^o The *Yoga*, which though bearing the same names as the *Yoga*, has no reference to it, as shall be further explained. 3^o The *Gurua*. 4^o The *Tyagum* of the *Horjum*, being the unlucky period of the day; the three last being Astrological Elements. 5^o The *Ishtam* or places of the Planets in the Lunar mansions on the given day.

I shall only speak of these five articles in this place, because the manner of computing them is given in the third Memoir; but there are eight others which, being purely astronomical or astrological, do not belong to our province; and therefore, those who wish for an account of the latter, will find it annexed to the specimen of the Ravi and Chandra Pauchangams and Ephemerides inserted at the end of this work.

1^o The *Nacshatra*, or Lunar mansion in which the Moon happens to be on each day.

There are 27 regular mansions in the circumference of the Moon's periodical revolution; each contains therefore $13^{\circ} 20'$ of her Zodiac. Sometimes an extraordinary *Nacshatra*, named *Ahhijit*, is inserted between the 21st and 22d, in which case it takes $3^{\circ} 20'$ from the former, and $1^{\circ} 40'$ from the latter. The Tellinga Astronomers make no use of this extra *Nacshatra*.

The regular *Nacshatras* 27.

The extraordinary *Nacshatra* called *Ahhijit*.

Each mansion is divided into 30 guddias, the guddia into 60 viguddias, &c. so that one guddia is equal to $13^{\circ} 20'$, a viguddia to $13^{\circ} 20'$, and a para to $13^{\circ} 20''$, which denominations must not be confounded with the measure of time of the same names.—The mansion is more

The *Naza*, divided into guddias, viguddias and paras.

generally divided into four quarters, called *Padahts*, which are always referred to in the Ephemerides.

The names of the 27 Nacshatras are as follows:

Names of the Nacshatras.

1	Aswini	11	Purva Phalguni	21	Uttara A'shād'hā
2	Bharani	12	Uttara Phalguni	*	Abhijit
3	Kṛtikā	13	Hasta	22	Śravana
4	Rohini	14	Chitra	23	Dhanish'tā
5	Mṛgaśīras	15	Swa'ti	24	Satabhishā
6	A'rūrā	16	Viśā'khā	25	Purva Bhadrāpadā
7	Punarvasu	17	Anurādhā	26	Uttara Bhadrāpadā
8	Pushya	18	Jyēst'hā	27	Revati
9	Āshlāṣā	19	Mula		
10	Maghā	20	Purva A'shād'hā		

In each Nacshatra there is a particular Star called *Yoga*, which serves as the index of the mansion. The following are their names, with those of the Stars of the European Catalogue which are supposed to be the same as the *Yogas* (*).

	Yogas.	Stars of the European Catalogue supposed to be meant.		Yogas.	Stars of the European Catalogue supposed to be meant.
1	Viśvambhā	γ or β Arietis	15	Vajra	Arcturus
2	Pṛithi	35 Arietis	16	Asṛij or Siddhi	24 Libræ
3	Ayushman	Alexone	17	Vyātipā'ta	8 Scorpii
4	Sambhū'gya	27 Tauri	18	Var'ya	Antares
5	Sa'bhāna	either 113, 116, or 117 Tauri	19	Parigha	34 or 35 Scorpii
6	Atigandha	perhaps 133 Tauri	20	Siva	2 Sagittarii
7	Sacurman	2 Geminorum	21	Siddha	Φ Sagittarii
8	Dhriti	2 Cancri	*	Abhijit	α Lyre
9	Sūta	49 or 50 Cancri	22	Sa'dhya	α Aquilæ
10	Gandā	Regulus	23	Sobha	α Delphini
11	Vaidhāt	perhaps 70 or 71 Leo	24	Sucra or Sabra	β Aquarii
12	Dhanya	2 Leonis	25	Brāhmaṇ	α Pegasi
13	Vya'gha'ta	γ or δ Corvi	26	Maha Jodra	γ Pegasi
14	Harsana	Spica Virginis	27	Vaidhriti	ζ Piscium

(*) It is foreign to the object of this Paper to enter into an account of the position of these Stars in the heavens: all that I shall observe at this place is, that in taking their Latitude and Longitude out of the Hindu Tables their *Fiakha* and *Sigana* (being corresponding terms), the former is to be considered as an arc of the Meridian which intersects the Star and the Ecliptic, and the latter as the portion of the Ecliptic which is intersected by the same Meridian and the Equinoctial Colure.

22. The *Yogā* or *Yoga*: which, though bearing the same name, and in the same number as the *Yoga* first exhibited in the preceding catalogue, yet has no Astronomical reference to it, is the time during which the sum of the motions of the Sun and Moon amounts to one *Nacshatra*. Thus if it be found to amount to 102 107 of a *Nacshatra* in any *Yogā* (considered as the first) at 22 507 of time, the following, or second *Yogā*, will begin at 58 287 after Sun rise the next day. (*)

Of the 27 *Yogās*, named as the *Yogas*, of the respective *Nacshatras*, seventeen are nearly equal to sixteen days.

23. The *Curnā*, or *Carana*—is the time when the Moon's motion from the Sun amounts to 6°, there being two *Caranas* in one *Tithi*. There are eleven *Caranas* in all, of which seven are ordinary and moveable, and named *Caras*: and four extraordinary and fixed, called *Nāḥira*.

The ordinary *Curnas*, or *Caranas* are specifically named as follows:—

- | | |
|-------------|----------------------|
| 1. Bhāva, | 5. Yurka or Gurajah, |
| 2. Bhālava, | 6. Warmji, |
| 3. Coolava, | 7. Bhudra, or Vuati, |
| 4. Dhātālā, | |

The Extraordinares.

8. Soyami or Charoul. 9. Chaleepaduk. 10. Nagara. 11. Cinastoghna or Rhinostogma.

The first *Curnā* begins when the Moon is 6° from the Sun; and the seven moveable ones being eight times repeated in successive order, include 342°.—The Moon's Synodical orbit being considered as divided into 200°, there remains 18° which she wants to complete her revolution; and these are allotted to the 8th, 9th and 10th *Curnas*; but the first six degrees after the conjunction belong to the 11th, or last.

42. The *Tyāgyā* of the *Farjā* (pronounced both by the Tamuls and Telingas *Thynjam* of the *Warjam*).—These terms are always employed together in the Calendar, the *Farjā* being that portion of a *Nacshatra* which is deemed unlucky, and the *Tyāgyā* the time of the duration of the unlucky period. This time is determined by a certain point in each *Nacshatra* called its *Bhāva*; that which the Moon's Disc takes, by her absolute motion, to traverse it, is the *Tyāgyā*; and its mean duration is 4 gaddias; but its true one more or less, according as the Moon's continuance in the same *Nacshatra* happens to be more or less than 60 gaddias.

50. The *Chārum* or *Pādachārum* (pronounced *Ishārum* by the Tamil astrologers)—a term used in the Hindu Ephemerides, signifying the daily aspect or position of the planets; answering to the same signification as *Jurnal-patrick*; though the latter means more precisely their aspect at

(*) The duration of a mean *Yoga* is 546.279, 215.75, but the apparent one varies in proportion with the Sun and Moon's respective apparent motions, which depends on the place of their Apogees and affords a great variety of combinations. Vide page 174.

any instant of time. The manner of computing these will be found at page 122 of this work. (Vide also Glossary).

It would be a waste of time to enter into any further account of the other Astrological elements which are inserted in the *Uchandra Panchangam*, independently of the five preceding ones, such as the *Crantam*, *Pethai*, and *Latta*. Some notice of these, however, will be taken in the IVth Appendix at pages 308 and following.

Supplementary articles of the *Panchangam*.

ARTICLE 3.

Computation of the mean Elements.

DEFINITION.

Definition of the mean Tithi.

Its duration 59g. 3v. 3sp.

Time of the true Tithi variable.

Depend principally on the revolutions of the Moon's Apogee.

A mean Tithi or Tithi, (a Lunar day) is the time during which the Moon moves through 12° of her Synodical orbit supposed to be divided into 360°; its duration is therefore 59g. 3v. 3sp. Hindu time, or 23h. 37'. 27½". European time: of these there are very nearly 371 in a Solar year. (*)

The duration of the True, *Sphuta* or *Sputa* Tithi depends on the apparent relative motion of the Sun and Moon. For a very long time the duration of the true Tithi is not sensibly affected by the motion of the Sun's Apogee; but their longer or shorter duration depends principally on their occurring at the time when the Moon is nearer or further from her Apogee, the former being only of 357 revolutions in a *Calpa*, and the latter revolving 485203 times in a *Mahayug*.

ELEMENTS.

Elements.

The Elements which are required for computing the articles of the Lunar and Solar Calendar, are principally as follows:

1. The Sun's mean place in the Hindu Ecciptic called *Ravi Madhyama Graha*.
2. The Moon's Do. *Madhyama Chandra Graha*.
3. The place of the Sun's Apogee in Do. called generally his upper Apis, or *Ravi (Tunga) Mandocha*.
4. The Moon's Do. *Chandra Mandocha*.
5. The *Ayanamsa*, or *Ayana Bhagan*,—meaning the arc comprised between the Vernal Equinoctial point (*Mesha Ayana*) and the first in the Hindu Sydereal Ecciptic. This latter Element is required for referring all the computations made on the fixed, or Sydereal, to the moveable, or Tropical Sphere.
6. The obliquity of the Ecciptic which the Hindus take to be constantly 23°.

All these Elements are to be resolved by means of the *Trin*, or *Tratricka* (more generally pronounced *Trinitica*), the common role of three; and are therefore, no otherwise difficult to compute than on account of the immense dimensions of the quantities, with which the operations are to be performed. For all these we have the following data.

(*) Tellinga Astronomers allow something more for the length of the mean Tithi, which according to theirs is 59g. 3v. 40p. 53a. Vide page 122.

1st The Sun performs 4320000 *Bharganas* or Syderial revolutions in a Maha yug; and in the same period of time there are 1577917828 natural or *Bhumi Savan* days.

2nd The Moon—57763336 in the same period.

3rd The Sun's upper Apais—357° in a *Calpa* or 1000 Maha yug, which *Calpa*, therefore, contains 1577917828060 *Bhumi Savan* days.

4th The Moon's Apogee—489303° in a Maha yug, with an additive *Bijah* or correction of 4 revolutions in the same space of time.

5th The *Ayanas* or Equinoctial points, called sometimes *Granti Palas*, or Nodes of the Ecliptic—600 *Revolutions* (or *Librations*, in whichever way it may please the computer to consider the Hindu precessional variation) in a Maha yug.

The revolutions of the Moon's ascending (*Raha* the head) and descending Nodes (*Keta* the tail of the Dragon), which proceed in *Antecedentia*, are not required for computing the common articles of the Kalendars, being only wanted for Eclipses and Occultations. Of these, however, there are 232238° in a Maha yug, with a *Bijah* of 4° as for the Moon's Apogee.

These dates are thus presented, on a supposition that the reader is already informed that a *Calpa* consists of 432000000 Solar Syderial revolutions, with a Twilight, or *Sandhi* of 1728000 years—that this period contains 14 *Manwantaras*, each of which contains 308448000 years. That a Maha yug is equal to 4320000 years, comprehending four lesser yugs, or periods of conjunctions; viz. The *Satya yug* 1728000° (equal to the *Sandhya* which precedes the *Calpa*)—the *Treta yug* 1296000°—the *Dvapara yug* 864000°—and the *Call yug* 432000°; of the latter of which, in the year of Christ 1822, there were 4923 expired; the 4924th beginning on Thursday the 11th April of the said year, New Style.

That sort of time which the Hindus call *Saura*, may be converted into degrees, &c. by the following Table.

Hindu expression.	Sarriah Sidhanta.	Tellinga.	Degrees.	Designation.
A Year	Samsrat sara	Mana	360°	12 Rasis or Signs
Month	Masha	Masha	30°	1 Rasi or 30 Bagahs
Day	Dina	Theidi	1°	1 Bagah
Hour	Danda	Gudha	1'	Cala
Minute	Vicala	Viguddha	1"	Vicala
	Pranscala		10"	1 Pranscala
Second	Costacala	Para	1"	Costacala

The time so expressed, may be converted into Solar Syderial time by means of Table XVI.

Data.

Revolutions of the Sun, Moon and their Apogees in a Maha yug or a Calpa.

Of the Equinoctial points.

The Calpa, Sandhi, Manwantaras, Maha yug and 4 lesser Yugs or periods.

Saura time expressed in degrees, &c.

FIRST OPERATION.

For the *Strositidi Digona*.

Strositidi Digona.

The *Strositidi Digona* means the number of natural days expired from the beginning of the *Calpa*, or grand Astronomical Epoch when the Planetary motion commenced, to any proposed day. The rule for finding that period of time, though necessarily obscure, is easily explained.

PRECEPT.

Precept.

1^o Find the number of *Saura* years expired of the *Calpa* on that which is proposed, by adding together the *Sandhi* which precedes the *Calpa*; six *Manwantaras*; twenty-seven *Maha* yugs; the *Satya*; *Treta*; and *Dvapara* yugs.—Subtract the number of years employed in the Creation, which is 17064000, and add to the remainder the years of the *Cali* yug expired; the sum is the *Strositidi Digona* in *Saura* years.

2^o Multiply the same by 12, and you have it in *Saura* months.

3^o There being 1393336 intercalary Lunar months in a *Maha* yug, find the number due to the *Strositidi Digona* in months, which add to the former.

4^o Multiply the sum by 30, and you have the Lunar days or *Tidhis*.

5^o There being 2508222 superabundant, or *Cakaya* *Tidhis*, in a *Maha* yug, find the number due to those found by article 4, which subtract from the same, and the remainder gives the *Strositidi Digona* in *Bhumi Sava*n days.

Rule.

These five operations are combined in the following Example for the year 1921 current of the *Cali* yug.

EXAMPLE I.

	Saura years.
1 ^o Sandhi or Twilight of the <i>Calpa</i>	1728000
Six <i>Manwantaras</i>	1830688000
Twenty-seven <i>Maha</i> yugs	110640000
The <i>Satya</i> yug equal to the <i>Sandhi</i>	1728000
The <i>Treta</i> yug	1296000
The <i>Dvapara</i> yug	864000
Sum	1972944000
Subtract time employed in the Creation	17064000
Remainder	1955880000
Add the years expired of the <i>Cali</i> yug	4923
<i>Strositidi Digona</i> in <i>Saura</i> years	1955884923
2 ^o Multiply by	× 12
	3911760846
	1955884923
The same in <i>Saura</i> months	23470619076

30 For the number of Intercalary or Adigah months due to the same period,
 Say As the number of Saura months in a Maha yug - - - 51810000
 To the number of Adigah months in the same - - - 159333
 So the number of months above found - - - 23470615070
 To the number of Adigah months sought

$$\frac{159333 \times 23470615070}{51810000} \quad \text{add } +721381689$$

Number of Lunar months - - - 21192003763
 Multiply by - - - $\times 30$

Number of Lunar Tithis - - - 725760112910

50 For the number of Superabundant Lunar days, and Sirostidi Digana in Bhumi Saura days.

Say As the number of Tithis in a Maha yug - - - 1603000080
 To the number of Chaya Tithis in the same - - - 23082152
 So the number of Tithis above found - - - 725760112950
 To the number of Chaya Tithis sought

$$\frac{23082152 \times 725760112950}{1603000080} \quad \text{Subtract } - 11356018175$$

Sirostidi Digana in Bhumi Saura days 714401994775

SECOND OPERATION.

For the Sauta dina, or feria on which falls the last conjunction of the Luni-solar year 4923 from the Cali yug.

The Sirostidi Digana in Bhumi Saura or natural days being divided by 7

$$7 \overline{) 714401994775} (102057727824 \text{ weeks}$$

and the remainder 0 being counted from Saturday as Zero (because the Creation is supposed to have been completed on Sunday) shows that the Luni-solar year 4923 ended on a Saturday, which concurred therefore with the 30th or Amavasya Tithi of the Lunar month Phalguna of the said year; and shows that the Prathama Tithi or first day of 4924 fell on a Sunday.

Sauta dina or last day of conjunction.

ARTICLE 4.

Before we proceed any further, we shall consider (with a view to save time) the method according to which Tellinga Astronomers compute the Sirostidi Digana in Bhumi Saura days, without undergoing the trouble of the preceding long process.

Tellinga process Sirostidi.

Although the Precept disclosed in the 3d Article be the fountain head from which all other methods were derived, yet the extreme length of its operations has tempted modern Tellinga Astronomers to search for shorter Cycles wherein the ratio of the intercalary months and superabundant Tithis might be preserved, and they have accordingly computed that in 180000 Saura years, there are exactly 66389 Adigah months; and that in 1335834 Lunar months, there are 6270363 Chaya Tithis. This Cycle of 180000 affords, therefore, a convenient proposition for computing some of the Elements with perfect accuracy, but from these are to be excepted

the position of the Sun's Apogee, which (as we have already hinted) moves only at the rate of 1' in 517 Saura years, and the precessional variation at that of 54" in a year. These, therefore, require much longer periods, and for this object the following method was found perfectly competent.

PROOF.

Precept.

1st Compute the *Stroostidi Digana* in Bhumi-sava days by the Sastra rule for the end of the last day of the Devapar yug (vide Example I). This will be a constant quantity, to which if you add the *Ahargana*, or number of natural days expired from the beginning of the Cali yug to the proposed Epoch, you will have the *Stroostidi Digana* for the same, just as if it had been computed by the long process.

EXAMPLE II.

Rule.

Let the *Stroostidi Digana* for the last day of the Devapar yug be required, for the purpose of deducing therefrom that for the last day of the year 4923 of the Cali yug.

1st Not to repeat what has already been done in the first Example, take the *Stroostidi* in years for the end of the Devapar yug, as found therein; which is 198598000 Saura years: proceed as before, and you will have the same in months 23470560000. Hence for the Adigah months and Cshaya Tiddis,

$$\begin{array}{rcl}
 \frac{198598 \times 23470560000}{518400000} & \text{Adigah months} & 721362874 \\
 \text{Which add to the sum of months} & & 23470560000 \\
 \text{Number of Lunar months} & & 24121012874 \\
 & \text{Multiply by} & \times 30 \\
 & & 723630386220 \\
 & \text{and} & \\
 \frac{2508239 \times 70415688870}{160000000} & \text{Cshaya Tid. Sub. —} & 11355989893 \\
 \text{Stroostidi Digana in B. Sava D. last of Devapar} & & 714402296627
 \end{array}$$

Now this quantity 714402296627 B. S. days once obtained, becomes a constant number, which combined with the Tellinga rule, will serve in future for finding the *Stroostidi Digana* of all Epochs which do not exceed higher than the beginning of the Cali yug.

Ahargana.

2nd For the *Ahargana*, or time expired from the commencement of the Cali yug to the end of the year 4923.

$$\begin{array}{rcl}
 \text{Say As the number of Saura years in the Cycle} & & 180000 \\
 \text{To the number of Adigah months in the same} & & 68229 \\
 \text{So the number of years of the Cali yug expired} & & 4923 \\
 \text{To the number of Adigah months sought which add} & & \\
 \frac{68229 \times 4923}{180000} & & 1815 \\
 \text{Then multiply } 4923 \times 12 \text{ number of months} & & \text{add } 59076 \\
 \text{Number of Lunar months sought} & & 60891
 \end{array}$$

This Element will be found	1798166	[43 38 7 12]
Neglect the fraction, and subtract the Luni-solar Ahargana computed		
at Article 4	— 1798148	

Difference	18 days.
------------	----------

For the jasta position of the beginning of the Solar and Luni-solar years.

But by the respective Precepts, the remainder of the Solar Ahargana after division by 7, is to be counted from *Friday*; and that of the Luni-solar from *Thursday*, therefore when the Solar is the greatest of the two, one day is to be added to, and when least subtracted from, the difference. In the present case, the interval should therefore be increased by an unit, which makes it 19 days.

Now the remainder of 1798166, after division by 7, being 6, the same being counted from *Friday*, gives *Thursday*; and by the rules formerly delivered, will be found to fall on April 11th, A. D. 1822, *Sydereal*, and (and on account of the fraction $43^{\circ} 38' 7'' 12'''$ which exceeds 30) on the 12th, *Civil* account. Subtract therefore 19 days from 11th April, and we find *Saturday*, 23d March N. S. the *Sydereal* date of the Soota dina sought.

We now want the *Civil* and *Sydereal* date in European expression, of the 1st day of the Solar month Poongoni, A. Cal. 4923, for which referring to Table III, we have

Ahargana 1st Chaitram above found	1798166	43 38 7
Subtract absolute duration of Poongoni		30 20 21 2

Ahargana 1st Poongoni A. C. 4923	1798136	23 17 5
----------------------------------	---------	---------

and the sum of days after division by 7, leaving a remainder of 4 to be counted from *Friday*, indicates *Tuesday* the Soota dina sought.

Using, therefore, any Kalendar, and counting 30 days backwards from the 11th April, we find *Tuesday* the 12th March *inclusive*, (the 11th being the last day expired), which is the *Sydereal* date of the 1st Poongoni European account.

Again, the fraction $23^{\circ} 17' 5''$ (below 30) shows that on the beginning of that month the *Sydereal* and *Civil* account coincided, and since the 1st Poongoni fell on the 12th March *inclusive*, and the Luni-solar Soota dina on the 23d, it follows that the Solar date sought is the 12th Poongoni, and that the *Sydereal* and *Civil* account coincide; altho' on account of the fraction of the Solar Ahargana for 1st Chaitram 4924; $43^{\circ} 37' 57''$ (above 30) the *Sydereal* month is of 30, the *Civil* is of 31 days.

The date of the last *Anuvatsya*, 30th Phalguna of the year 4923, is therefore, *Saturday* the 13th; and that of the *Pratham* Tithi, the 1st of the Lunar month Chaitra 4924, *Sunday* the 15th Poongoni of the Solar year 4923.

The following Elements are, therefore, all computed for the 12th Poongoni.

N. B.—A difference will be found between these results, and those which would be obtained if the Elements of the *Asiatic Siddhanta* (those of the Solar Kalendar) were to be used; for the

Abargana for the 1st Chaitram of the Solar year 4924, on those principles, D. C. V. R.
 instead of $(4^h) 43^m 38^s 7^{\circ}$, would be (4) 20 12 30
 From which subtract Root for Poongoni, Table III, column I, — (2) 20 21 2

The Root of Abargana 1st Do. (1) 20 51 28
 would be *Monday*, Syderal account, instead of *Tuesday*, found by the process of the Surriah
 Siddhanta. But on account of the fraction $59^h 51^m 28^s$ (exceeding 30) it would be *Tuesday*,
Civil account, which we have before found to fall on the 12th March 1822. The consequence
 would also be, that the Syderal month of Poongoni 4923 would count one day more than the
 Civil one; and that all the Civil dates in the said month would be one day in advance of the
 Syderal account, which is not the case in the present computation.

We have thus been obliged to suspend the computation of the mean Elements, from the
 necessity of fixing the date of the Luni-solar *Srôta dina* according to the Solar Calendar,
 without which it would be impossible to determine the circumstance of the intercalary and
 expunged Tithis, in the Chandra Panchangum. We shall now resume it in the following
 Article.

ARTICLE 5.

THIRD OPERATION.

For the *Rasi Madhyama Graha* or mean place of the Sun in the Hindu Zodiac.

$$(*) \frac{4300000 \times 114401091773}{1571917829} \quad . \quad . \quad . \quad . \quad . \quad 11 \quad 2 \quad 26 \quad 30 \quad 37$$

FOURTH OPERATION.

For the *Chandra Madhyama Graha*, or mean place of the Moon

$$\text{in Do.} \quad \frac{57122136 \times 114401091773}{1571917829} \quad . \quad . \quad . \quad 11 \quad 21 \quad 15 \quad 34 \quad 24$$

FIFTH OPERATION.

For the place of the *Rasi Tunga Mandooka*, or Sun's Apogee

$$\text{in Do.} \quad \frac{381 \times 114401091773}{1571917829} \quad . \quad . \quad . \quad 2 \quad 17 \quad 17 \quad 17 \quad 54$$

a Calpa.

(*) The form in which I present these expressions has been objected to as unauthorized by custom, for generally a quantity placed on the right side of an Equation of this sort, implies a remainder; but a different disposition of the figures would have perplexed the reader's eye, and the results when referred to are more readily found when classed in order after the expressions. Mr. Samuel Davis has followed the same notation without its being objected to in Europe, I rely on the same indulgence.

SIXTH OPERATION.

For the place of the *Chandra Mandacha* or Moon's Apogee in Do.

$\frac{469213 \times 714404094775}{1517917828}$	-	-	-	-	-	7 2 57 26 12
<i>Correction of Bījah</i>						
$\frac{4 \times 714404094775}{1517917828}$	-	-	-	-	add	0 1 38 27 10
						7 4 35 53 22

SEVENTH OPERATION.

For the *Ayananta* or *Ayana Bījahs*. (*)

$\frac{600 \times 714404094775}{1517917828}$	-	-	-	-	-	Revolutions. Parts.
						(271650) 683742 or 8 6 8 4 17
						and 8 6 8 4 57
						— 6
						2 6 8 4 57
						× 3
						10 6 18 24 14 51 0 19 50 25 29

The *Ayananta* on the 12th of Poongani of the Solar year 4923 of the Cali yug, being the day of last *Amavasya* (conjunction) of the Luni-solar year of the same denomination, is therefore - - 0 19 50 25 29

(*) I cannot dissent the operation for finding the *Ayananta*, the most important Element of Hindu Astronomy, in as much as it is the Equation which transfers all the computations made on the Syderal, to the Tropical Sphere, without offering a few words on the formula used in the text, and the view which modern European Schollasts have taken of the theory of that Element, to which some differ very materially. All that the Surriah Siddhanta says on the *Ayananta*, is comprised in the following few lines, in reporting which I use Mr. Davis's version.

"The *Ayananta* moves Eastward thirty times twenty in each *Maha* yug. By that number (600) multiply the *Ahargana*, and divide the product by the number of seven days in a yug, and of the quotient take the *Bhāṣa* (supplement to or excess over 180°), which multiply by 3, and divide the product by 10; the quotient is the *Ayananta*. With the *Ayananta* correct the *Grāha*, *Crauti*, the *Ch'haga*, *Chandala* and other requisites to find the *Puṣkī* and the two *Pishunas*.

"When the *Uṣṇa* (Hypothesis) is less than the Surriah *Ch'haga* (the Gnomonic Shadow of the Sun) the *Pratya* *Chakra*, moves Eastward, and the *Ayananta* must be added; and when none, it moves Westward, and the *Ayananta* must be subtracted."

The commentary goes on to say, "that if the Sun's true place (Spota *Grāha*) computed by the *Ahargana*, be less than that found by his Gnomonic Shadow, the *Ayananta* must be added (and vice versa). In present times (adda the *Tika*) the *Ayananta* is added."

From the above passages, the modern Hindu Sastras (and Mr. Davis after them) conclude, that the Equinoctial points are considered in the Surriah Siddhanta, as vibrating from the 2d degree of *Mīna* ♈, to the 27th of *Mīna* ♉;

NOTE.—Since the Equinoctial points complete their revolutions 600 times in a Maha yug, and during each, pass through a space equal to four times 27° , or 108° of the Elliptic, which is $\frac{1}{16}$ ths of 360° , (its whole circumference) the remainder, of the preceding operation, after subtracting the *Bhujā*, is drawn into $\frac{1}{16}$. Now for the annual variation, we have according to former Precepts $\frac{1}{16} \times 600 \times 360 = 13500$ revolutions, equal to 54° exactly. Hence, for finding the Ayanams at any particular time, the Sastra rule may be dispensed with; for it needs only be remembered that the fixed and moveable Solar Zodiac, are supposed to have been coincident at the expiration of the 3600th year of the Cali yug; and that the Equinoctial points have a retrograde motion of $54'$ in a Syderal year. Therefore, to find the Ayanams for the end of the Solar year of the Cali yug 4923, we have $4923 - 3600 = 1323$, and $1323 \times 54' = 19^\circ 50' 42''$.—This result differs from that found by the 7th Operation by $17^\circ 31'$, but the latter was for the end of the *Luni-solar* and not the *Solar* year 4923, which began 19 days later. True it is, that this difference accounts only for $2^\circ, 8'$; but the Tellinga Astronomers are contented to use the *Druva* or Epoch of the year 3600 of the Cali yug for common computations, because they generally neglect the seconds. One thing is certain, however, which is, that if at the end of the said Solar Syderal year there was truly no Ayanams (as they suppose), their method is more secure than that of the Sastras. The Table XXXV of this collection has been constructed with reference to the *Druva*.

For the period in time of the revolution of the Ayanams we shall observe, that as there are 600 *Baghanas* (for so they are called in the *Varasankhita*) in a Maha yug and of Saura years in the same period 4320000, it follows that one Baghana of the Ayanams is equal to 7200 years. The Hindus divide that period into four quarters, called *Padahs*, during the first and fourth of which

and from the 3d degree of *Cengra* III., to the 27th of *Tula* II., of the fixed Indian Elliptic; for it must not be imagined that this conclusion originated with the gentleman above quoted; the same having been distinctly explained to me in Madras by the College Sastra (an able and aged Native Astronomer) in the year 1814, which is more than 35 years after Mr. Davis had written his tract.

The exact meaning of the word *Pete Chakra* used in the Sangserre text, is not sufficiently known to me to draw any satisfactory conclusion therefrom; but the term *Chakra* clearly means a wheel or circle, and if in the present case it may be taken in the sense of an Epicycle, it would not be a forced inference to consider it as one of a Radius equal to 27° of the Deferent, whose center would lie at the Equinoctial point, revolving on itself, and through which the line of *Rishis* (that which is supposed to pass through the center of the great Orb, and to be directed towards certain Stars of the great Bear; and at which the four fixed and moveable Solar and Lunar Zodiacs coincide after certain revolutions of time) should pass, in the plane of the Elliptic. If such a scheme could be admitted, it would not be difficult to comprehend how a point in the Axis of the moveable Orbit, revolving in the Epicycle and proceeding from the point of coincidence towards the East, might after 1800 years (one *Padah*, or quarter of the Ayanams) reach its greatest Eastern Elongation, equal to 27° of the Deferent, then seem to move during 1800 years more in *antecedentia*, after which it would again fall in the line of the *Rishis*, in a point of superior conjunction when the Ayanams would again be equal to Zero; from which, after passing through its greatest Western Elongation, it would proceed in consequentia, and in a complete period of 4×1800 , or

the *Crusti-Pata Gati* is additive, and consequently the *Ayanansa* is increasing, and during the second and third decreasing.

The obliquity of the Ecliptic is supposed to be constantly 24° ; and it must be a matter of astonishment to perceive, that those who were able to discover (though imperfectly) the precessional variation, should not have even suspected the diminution of the former.

There remains now to explain the word *Bhuja*, which was used for the first time in the last Operation; but of which we shall make frequent use in the sequel.

The *Bhuja* is always understood to be the supplement of an arc of 6 or 12 signs, or the difference above 6 signs, and below 12 signs, if the arc exceeds 6 or 9 signs; thus:

1. If the arc exceeds 3 signs - Subtract from 6 signs.
2. If it exceeds 6 signs - - Retrench 6 signs from the arc.
3. If it exceeds 9 signs - - Subtract the arc from 12 signs.

All Hindu Tables and Rules are adapted to these Rules.

The mean Elements being thus computed, they are, when collected in one view for reference, as follows:

Sun's mean place 12th Poongoni 4923	-	11	9	26	30	37
Moon's Do. Do.	-	11	21	15	34	24
Sun's Apogee Do.	-	2	17	17	17	54
Moon's Do. Do.	-	7	4	35	53	22
Ayanansa Do.	-	0	10	50	23	29
Obliquity of the Ecliptic	-	0	24	0	0	0

We shall now pass to the computation of the true, or *Sputa* Elements.

1900 years from the outset, and after having revolved through an arc equal to 108 degrees of the Deferent (360 of the Epicycle) return to its original point of coincidence.

A similar notion occurred to the Arabian Astronomer Tebiti-Ben-Charn in the IXth century, when he attempted to account for the change in the obliquity of the Ecliptic (unknown to the Indians, who always take it to be 24°) and the inequality of the precessional variation. He supposed an Epicycle at the Equinoctial point and found with reference to it that the Stars sometimes appeared to move towards the East and at others towards the West, with unequal velocities; that doctrine was victoriously combated by Rhinboldus and Regiomontanus; nevertheless, by an hypothesis much resembling it, it so happens that the small quantities of the Nutation of the Earth's Axis, have been resolved by our own Astronomers during the last century.

But what leads me to abandon this hypothesis, is, that I perceive no where in the Hindu *Sastras*, any trace of a variable motion in the Equinoctial points, which, whether the *Crusti-Pata Gati* (literally the motion of the Nodes of the Ecliptic) be considered as a libration or a revolution, should be felt particularly, either at the Limits, or the Eastern and Western Elongations; such a notion being especially inseparable from that of an Epicycle. Nor can it be ascribed to ignorance on the part of the Hindus, who have shown themselves to be fully aware of the effect above adverted to in their theory of the Anomalistic Equation, where they increase or decrease the Radius of their Epicycle; as it is supposed to approach or recede from the Sigriles, and take their *Paridh-anasa* (Epicyclic degrees) equal to Zero, between *Sama* and *Vatsana* (odd and even), i. e. at 3 and 9 sign Anomaly.

ARTICLE 7.

For the true Elements and the Anavasya and Prathama Tithi of the year Cali yug 4923.

In eliciting the *true* Elements I shall follow the course of the Southern Hindu Astronomers in their various contrivances for saving as much labour as possible, consistently with correct deductions. Several of these methods are new to Europeans.

EIGHTH OPERATION.

For the Sun's true place in the Hindu Zodiac, or Sputa Graha.

Subtract the ☉'s Madhyama Graha	-	-	11	9	26	37	The Sun's true place,
From the place of his Apogee (Mandocha)	-	-	2	17	17	18	
Manda Kendra or Argument of Anomaly,	-	-	3	7	50	41	
From which subtract	-	-	6	0	0	0	
Bhujah or supplement	-	-	2	22	9	19	
or 82° 9' 19" = 559°							

With 82° refer to Maracanda Anomalistic Table (Ravi P'hala, Table XXV.)

take for 82°	2°	9'	18"
83	2	9	36

And for the remaining 9' 19" 18

$$\text{Say } 60 : 559 :: 18 : \frac{559 \times 18}{60} = 2 \quad 47 \quad \begin{matrix} \text{Vicala,} \\ \text{Cast.} \end{matrix}$$

which last fractional part 47th exceeding 30th, merge into the vicalas and take 3.

Equation for 82°	-	-	-	2	9	18
Fractional part	-	-	-	-	-	3
Manda P'hala or Anomalistic Equation	-	-	-	2	9	21

Now this Equation (*) being additive for midnight, the apparent time, or instant of the Sun being actually on the other Meridian, must be somewhat later than the mean time of midnight, or when his mean place answers to the Meridian. The Equation due thereto (which always depends on the Sun's Anomalistic Equation) is what the Hindus call *Arca-Bahoota Samskara*, or *Arca Bhagabala*: for the correct resolution of which

Arca-Bahoota Samskara or *Bhagabala*.

(*) Mr. Davis having demonstrated that Maracanda's Tables were constructed by help of the Trigonometrical Tables of which he has investigated the theory, it would be useless for me to prolong this paper by using the Pindas instead of the Equations. Those, however, who may be desirous to practice the long process, will find in Table XXXI a canon of sines, cosines, and versed sines, which has not yet appeared in print.

Say 250° the revolution through the diurnal Circle or 1296000°
 $59' 8''$ Sun's mean motion in 1 day - 3548
 So Equation due to $52^\circ (2^\circ 9' 21'')$ - 7758

$$\frac{3548 \times 7758}{1296000} = 21'' \text{ The Arca Bhagabala. } (*)$$

Sun's mean Longitude	-	11'	5'	25'	37''
Manda P'hala	-	-	2	9	21
Arca Bhagabala	-	-	-	-	21

Sun's Sputa Graha, or true place for

apparent midnight at Lanka	-	11	11	35	19
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NINTH OPERATION.

For the Sun's true motion or Sputa Gati.

The Sun's true motion.

The Sun's mean motion in one day, being equal ^{XXIV} to $59' 8''$, with the Bhujah of Manda Kendra found before $52^\circ 9' 17''$ (8th Operation), referring to Table ^{XXIV} $\frac{1}{4}$, in the column of difference from mean to true motion, you find $18''$; and as the difference for one degree is only $3'$, the quantity due to $19' 17''$ may be neglected.

Table I. \odot 's mean motion in one day	-	-	-	59'	8''
	-	-	-	+	18

Sun's Sputa Gati 12th Poongoni	-	-	-	59	26
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TENTH OPERATION.

For the Moon's true place, or Sputa Graha.

The Moon's true place.

From the place of the Moon's Apogee	-	-	-	7'	4'	50'	52''
Subtract her Madhyama Graha	-	-	-	11	21	15	54

Chandra Manda Kendra or Argument of Anomaly	-	-	-	7	13	20	19
From which retrench	-	-	-	6	0	0	0

Bhujah, or distance from Perigee	-	-	-	1	13	20	19
	-	-	-	or 43	[20	19	= 1219°

With 43° , referring to Table XXV, you find

for $43^\circ - 3^\circ 27' 26''$	-	-	-	44	+	3	50	54
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$$\text{Difference } 3 \ 28 = 208''$$

Then say : $60 : 208'' :: 1219^\circ : \frac{208'' \times 1219}{60} = 1^\circ 10' 23''$
 and for second difference

$$: 360^\circ : 208'' :: 5^\circ 27' 26'' : \frac{208'' \times 12146}{360} = 19 \text{ viculas.}$$

(*) In order to save the trouble of these computations, the Hindus generally take the Sun's Arca Bhaga'bala to be the 360th part of its Anomalistic Equation: thus $\frac{2.9.21}{360} = 21''$, and the Moon's $\frac{2.9.21}{27} = 4' 47''$, difference $4''$.

Hence, Equation for 43°

			3° 27' 25"
1st Equation	-	-	1 10
2d do.	-	-	19

Manda P'hala or Anomalistic Equation subtractive 3 28 55 —

For the Arca Bhagábala or Equation of the Moon's place from mean to true midnight, say: as 360° : to 2° 9' 21" (Sun's Manda P'hala, 8th Operation) :: 13° 10' 35" (Moon's mean motion in one day, 11th Operation) :

$$: \frac{2^{\circ} 9' 21" \times 13^{\circ} 10' 35"}{360^{\circ}} = 4' 43" \text{ the Arca Bahoota Sumscara, depending on the Sun's Anomalistic}$$

Equation, from mean to true midnight on the 12th of Poongoni, additive.

Thus we have

P's Madhyama Graha	-	-	-	11° 21' 15" 34"
Manda P'hala	-	-	subt. —	3 28 55
				<hr/>
				11 17 46 39
Arca Bhagábala	-	-	-	4 43
			+	<hr/>
Moon's Suta Graha or true place at apparent midnight				11 17 51 22
on the 12th of Poongoni at Lanca	-	-	-	

ELEVENTH OPERATION.

For the Moon's true motion or Suta Gati.

The Moon's mean motion in one day is 13° 10' 35": and her distance from Perigee is 1° 13' 20" (10th Operation) or 43' [20° 10'.

The Moon's true motion.

With 43° referring to Table XXV, you find

For 43°	-	-	50' 48"
44	-	-	49 46
			<hr/>
Difference			1 2

Then say: 60° : 20° 10' :: 62° : $\frac{20^{\circ} 10' \times 62}{60} = 30' 39"$ or 31'.

We have therefore P's mean motion in one day	-	-	13° 10' 35"
Equation for 43°	-	-	50 48
Proportional part	-	-	31
			<hr/>
Moon's Suta Gati or true motion on the 12th of Poongoni	-	-	14 1 54

TWELFTH OPERATION.

For the true distance and relative motion or Vi-Arca Indoo Graha and Gati.

☉'s Suta Graha	-	-	-	11° 11' 36' 19"
P's Do. Do.	-	-	-	11 17 51 22
				<hr/>

True distance and relative motion.

Soobvi-Arca Indoo Graha, or distance at midnight
the Moon having passed the Sun. 6 15 3

☉'s Sputa Gati	59	23
☾'s Do. Do.	14	1 34
Soohari-Arca Indoo Gati, or relative motion	13	2 23

which relative motion is the Element of the Sputa Tidhi; or true Luni-solar day due to the 12th Poongoni 4923.

THIRTEENTH OPERATION.

For the time due to distance or instant of Arca-Indoo Sangama.

Arca-Indoo Sangama, or Darshan. True conjunction.

The true distance of Sun and Moon at midnight of the 12th of Poongoni complete, or 13th commencing, according to astronomical reckoning was (preceding article) $6^{\circ} 15' 3''$, and the relative motion $13^{\circ} 2' 28''$, say therefore : $13^{\circ} 2' 28'' : 60^{\circ} :: 6^{\circ} 15' 3'' : \frac{60 \times 6^{\circ} 15' 3''}{13^{\circ} 2' 28''} =$

The time sought = $28^{\circ} 45' 32''$.

But the Moon had passed the Sun when it was true midnight at Lanka, and the notation of the Tidhi requires the knowledge of its juxta position to Sun rise (Art. 2, paras. 9, 10 and 14); therefore to express the time of conjunction in Solar time where midnight falls on the 45th gaddis,

Subtract therefrom time due to distance - - - $\frac{45}{28} 45 32$

True Amavasya after Sun rise of the 12th Poongoni current - 16 14 28

which marks the instant when the last or *Purnanasi* Tidhi of the Luni-solar month Phalguna ended, and the *Prathamā* Tidhi of the ensuing Chaitra began.

Notation of the Tidhi in the Panchangam.

Notation of the Tidhi in the Panchangam.

We have seen, Article 2, para. 10, page 72, that if a Tidhi happens to commence *after* Sun rise it is accounted to belong, not to its proper concurrent Solar day, but to the following one; therefore, although the present Tidhi was almost entirely spent in the 12th of Poongoni, yet it is to be coupled with the 13th, and so it will be found in the *Patra* for the Luni-solar year Calīyugam 4923, because the Solar month Poongoni having begun before Sun set, i. e. at $23^{\circ} 17' 4''$ (vide Kalendar) the Civil and Syderal accounts coincide during the whole month.

ARTICLE 8.

Hindu Gnomonics.

All the foregoing resolutions are confined to the Geographical position of Lanka, which is supposed to have neither Latitude nor Longitude, a primary process which in all cases is indispensable when using the Rules of the *Serriah Siddhanta*. The object of the present article is, to shew what those results would be at any other place not under the Equator and first Meridian; and for this purpose the Hindus have recourse to the Tropical or moveable Sphere, supposed by some to be that of their primitive Astronomy.

Considering of what importance the theory of Gnomonics is to Hindu Astronomy, it is surprising that so little should have been written upon it by European commentators; for although Mr. Davis has resolved some of its Problems with his usual sagacity, yet he has gone no farther than his own immediate purposes required. In order to fill this chasm in our present stock of information, I have collected in this article every case that appeared to me of importance; but if I have omitted any, the ingenious reader will easily supply the deficiency, by drawing Corollaries from those expounded in the Examples.

Although the present article professes to treat only of Gnomonics, yet I have found it expedient, for the sake of arrangement and expedition, to dispose along with what strictly relates thereto, of those Problems to which Gnomonics are auxiliaries.

The theory of these Problems rests of course, on Plane and Spherical Trigonometry, and every case expounded in the following pages is exclusively resolved on Hindu principles, and by help of Tables of their own, the formulae of which will be found annexed to Table XXX of this collection.

An account of the terms used in Hindu Tropical Astronomy and Gnomonics being indispensable, the names of the principal Elements are defined and explained in the following list.

DEFINITIONS.

Senku, or Sunka—The Gnomon.

Ch'hya or Chaya—Its Shadow.

Palabah, or Vishama Chaya—The Shadow of the Gnomon at mid-day, when the Sun is in the Equinoctial points.

Vishama Carna—The Hypotenuse of a right angled triangle formed by the Senku and the two sides of its Shadow under the preceding circumstances.

Madhyama Chaya—The mid-day Shadow at any other time of the year.

Sama-Mandala-Chaya—The Shadow when the Sun is East or West of the Gnomon.

Cranti Mandala—The Ecliptic.

Cranti Bagahs—The declination of a point of the Ecliptic.

Nari-Mandala—The Equator.

Soyana—Celestial Longitude considered in the same manner as that of the Europeans.

Vicshipa—Celestial Latitude.

Seva-desa-Paridhi—A circle of Longitude in any given Latitude.

Agra—The Amplitude.

Nutanaa, or Nata Bagha—Zenith distance.

Cshetija—The Horizon.

Lagna—The Arc of the Equator which passes over the Meridian in the same time with each Sign of the Ecliptic.

Madhyama Lagna—Mean Do. that of Lanka, the same Arc which rises above the horizon with each Sign of the Ecliptic.

Ullangu—The Lagna of any particular place, being the Arc of the Equator which rises above the horizon of that place, in the same time that each Sign of the Ecliptic rises.

Dinarda—Half the day.

Ratri Arda—Half the night.

Jya or Jaya—When connected with the name of any Element means its Sine.

Paramapa. Cramajaya—The Sine of the greatest declination of a Planet. As the Hindus take the obliquity of the Ecliptic to be constantly 24° , the above term when referred to the Sun, means the Sine of the obliquity.

SECTION I.

Description of the
Sanku or Gnomon.

The Sanku is a stait Rod, Pole or Pillar of Stone, such as we invariably see placed in front of every Pagoda in India, placed perpendicularly on an horizontal plane. The Hindus trace a Meridional line by describing concentric circles from the point on which the center of the Pillar is to rest on the ground, precisely in the same manner as Europeans do.

In construction.

Divisions.

Whatever be its height, the Sanku is divided into 12 angular, or digits, and each angular is subdivided into 60 vinculas. It thus serves as a scale for measuring the Ch'hya or Chaya, the length of the Meridional shadow; and a Rod is accordingly made of the same dimensions and divisions for that purpose.

In marking alternately the points where the top of the shadow cuts any of the concentric circles, they chase the time of 5, 6 and 7 dandas (or Indian hours of the *murta* account 60 to a day) before and after noon: This being done the arcs are bisected; the Meridian line is traced, and the four Dikas, or cardinal points; with the *Asta Dikas*, the four intermediate divisions are easily determined.

Dimensions of the
Equatorial circle,
and parallels of Latitude.

Before entering into the resolution of the Problems which depend on the length of the Meridian shadow, it is proper to enquire how the Hindus compute the dimensions of the Equatorial circle, and thence those of the parallels of Latitude of any given place.

Ratio of the diameter to the circumference.

Of their manner of resolving geometrically the ratio of the diameter to the circumference of a circle, I never saw any Indian demonstration: the common opinion, however is, that they approximate it in the manner of the ancients, by exhaustion; that is, by means of inscribed and circumscribed Polygons. However, a Native Astronomer who was a perfect stranger to European

Geometry, gave me the well known series $1 - \frac{1}{2} + \frac{1}{4} - \frac{1}{8} + \frac{1}{16} - \frac{1}{32} + \frac{1}{64}$ &c. to unit (*) being the ratio of the area of the Circle to the square of its diameter, or that of an Arc of 45° to Radius unit,—and $4 \times (1 - \frac{1}{2} + \frac{1}{4} \text{ &c.})$ equal to the circumference, the diameter being 1. This person reduced the first terms of the series before me, which he called *Bagah-Anoodandu*, or *Bagah-Apovacha*; to shew that he understood its use. This proves at least, that the Hindus are not ignorant of the doctrine of series; but I could not understand whether he pretended to make out his ratio of the Earth's diameter 1600 to Equatorial Circle 5059 (that which he used in all his computations) by means of these expressions.

Be this as it may, it is certain that according to their Trigonometrical Tables, the Radius, or Sine of 90° being equal to $37^\circ 18'$ (+), the diameter would be to the circumference as 1 : 3,14136, &c. (‡) so that dividing the diameter of the Earth into 1600 yojanas, it would give the Equatorial Circle 5026,176 yojanas. But it is somewhat singular to observe, that they should have preferred for constant use another ratio much less accurate, by their own account.

Dividing the diameter, as before stated, into 1600 parts, and multiplying the square of that number by 10, the root of the product $\sqrt{10 \times 1600^2} = 5059,6$ yojanas gives the dimensions of the Equatorial Circle. Or taking the ratios 1 : $\sqrt{10}$, otherwise 1 : 3,1619, &c. they have the same 5059,04 yojanas.—In all calculations of the Hindus that I have seen, they content themselves with using 5059yo, which is somewhat nearer to their Tabular ratio: but in the following calculations I have used the mean or 5059,3, which difference, however, is of little importance, considering the means that are used for determining the Palabah, the principal Element.

Sometimes when the Almanac makers pretend to be very accurate, they divide the diameter into 20,000 parts, and then using the above formula $\sqrt{10 \times 20,000^2}$ they have 62832y for the

Practical Rule for finding the dimensions of the Equatorial Circle in yojanas.

Quantity used 5059,3 yojanas.

(*) I owe the following note to Mr. Hyne's favour. "The Hindus never invented this series; it was communicated with many others, by Europeans, to some learned Natives in modern times. Mr. Whitt sent a list of the various methods of demonstrating the ratio of the diameter and circumference of a Circle employed by the Hindus to the Literary Society, being impressed with the notion that they were the inventors. I requested him to make further inquiries, and his reply was, that he had reasons to believe them entirely modern and derived from Europeans, observing that not one of those who used the Rules could demonstrate them. Indeed the pretensions of the Hindus to such a knowledge of Geometry, is too ridiculous to deserve refutation." I join in substance to Mr. Hyne's opinion, but do not admit that the circumstance that none of the *Sutras* mentioned by Mr. Whitt, who used these series could demonstrate them, would alone be conclusive. It cannot certainly be denied, that the inventors of the system of Hindu Astronomy possessed a knowledge of Geometry which their successors have not entirely preserved, and if we bring the question home to ourselves we are compelled to acknowledge, that thousands (even among the well informed) use La Place's formula without understanding the principles of their construction.

(†) The European Arc is $57^\circ 14' 24''$.

(‡) Do. as 1 : 3,14159 &c.

Dimensions of the Equatorial Circle: but all they gain is, that they exhibit the same ratio into minute parts, without any nearer approach to truth.

PROBLEM I.

Let SC be the height of the Gnomon, divided into 12 angular, or $12 \times 60 = 720$ vincular; CP the Palabah, or mid-day shadow at the Equinox. SP the Vishama Carna, or Hypotenuse of the Gnomonic shadow on the same day; and $\angle CSP$ be the Polar Altitude; which in the present case let it be $13^\circ 4'$ N. Say:

As Cosine Polar Altitude CSP	-	-	-	-	3348'
To Sine of the same	-	-	-	-	776',2
So height of the Sanku SC	-	-	-	-	720 vincular.
To $\frac{718'2 \times 720'}{3348}$	=	-	-	-	156,8 = 2 ang. 46,8 sin.

the length of the Palabah, or Equinoctial shadow at Madras: a constant quantity for that place.

Q. E. Id.

PROBLEM II.

Given the Palabah or Vishama Chya (above found)	-	-	-	Angular.	Vincular.
	-	-	-	2	46,8
Wanted the Acsha Bagahs, or the Altitude of the Pole?					

A

To determine the length of the Vishama Carna, or Hypotenuse SP, the angle at C being a right one, we have

$$\frac{2}{3} \sqrt{720^2 + 2 \cdot 46,8^2} = \dots \quad \text{Angular. Vincular.} \quad \frac{12}{9}$$

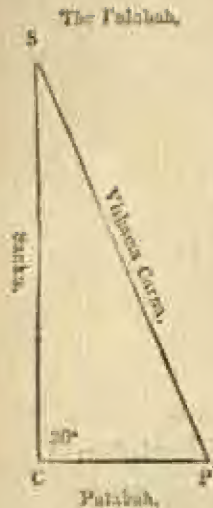
B

Then: As Vishama Carna	-	-	-	-	12	9
To Palabah	-	-	-	-	2	46,8
So Radius	-	-	-	-	3348'	
To	-	-	-	-	$\frac{12 \cdot 46,8 \times 3348}{12 \cdot 9}$	776'

the Sine of the Acsha Bagahs, the same as found by the Tables in the preceding Example, whose Arc is $13^\circ 4'$.

COROLLARY.

Should the Altitude of the Equator or angle CPS be required, the proportion would be, As Vishama Carna SP, to height of Sanku SC, so Radius, to Lumbajaya; properly the Cosine of the Latitude of a place, but called in this place the Sine of the Altitude of the Equator, which using the same quantities as above, would be $76^\circ 56'$.



The Acsha Bagahs
or Latitude.

PROBLEM III.

Given the Altitude of the Pole	-	-	-	-	13° 4'	Sera-desa-Paridhi, or circumference of the Parallel Circle to the Equator.
Whose Cosine is (Prob. I.)	-	-	-	-	3348'	
The circumference of the Equatorial Circle (page 93)	-	-	-	-	5059,3 yojanas.	
Wanted the Parallel Circle of Longitude due to the above Latitude (dist of Madras). Say	-	-	-	-		
As Radius	-	-	-	-	3438'	
Cosine Latitude	-	-	-	-	3348'	
So circumference of the Equatorial Circle	-	-	-	-	5059,3 yo.	
To	-	-	-	-	$\frac{3348' \times 5059,3}{3438}$	
	-	-	-	-	4925,9 yo.	
The Sera-desa-Paridhi, or circumference of the Circle of Longitude in the Latitude of Madras (that entered in Table XXXIV.) (*)						Q. E. In.

PROBLEM IV.

Given the circumference of the Circle of Longitude in the proposed Latitude (Prob. III.)	-	-	-	-	4925,9	Assignable Desentara in yojanas and in time.
The distance in degrees of the given place East or West from the first Meridian (Lanka)	-	-	-	-	4° 35' E.	
which in the present case let it be the Desentara of Madras. Wanted the Longitude in time and yojanas.						

A

Say : as 360° : 5059,3 :: 4° 35' : $\frac{5059,3 \times 4^{\circ} 35'}{360^{\circ}} = 64,4$ yojanas.

N. B.—At Madras the Hindus take this assignable Desentara in round numbers to be 65 yojanas, which however, gives too strong a difference in time.

B

To convert this quantity into time, say : As circumference of the Circle of Longitude 4925,9 yo.
: to a natural day, or 60 goddhas :: as 64,4 yo. : $\frac{60 \times 64,4}{4925,9} = 47$ sig. 4. paras.

Q. E. In.

The time due to the difference of Meridians.

N. B.—If the degrees and minutes of Longitude be converted into time according to the European method, 4° 35' will give 45° 57'; the Natives at Madras take it 45° 47' (+).

(*) In Table XXXIV will be found the Sera-desa-Paridhi, or circumference of the Circle of Longitude in yojanas, and the said-day Equinoctial shadow in angular, of the principal places in India.

(+) Vide Table XXXI.

PROBLEM V.

The Latitude found
by means of the Pa-
labah.

Given the Palabah of some unknown place, which let it be $3^{\circ} 30'$. Wanted its Latitude, or Acsha Bagahs.

(N. B.—This proposition is but a repetition of Problem II, but is introduced here in reference to the commentary in the Appendix, whose Problems are all resolved for the Latitude and Longitude of Banda, near Masulipatam.)

A

The Vishama Carna, or Hypotenuse of the Equinoctial shadow will be determined, as in Problem II, by the formula.

$$\sqrt{12^2 + 30^2} = \begin{matrix} \text{Ang.} \\ 12 \end{matrix} \quad \begin{matrix} \text{Vin.} \\ 30 \end{matrix}$$

B

Then say, As Vishama Carna $12^{\circ} 30'$: to Palabah $3^{\circ} 30'$, so Radius, to Acshajya the Sine of Polar Altitude $\frac{3438 \times 30}{1230} = 952'$ corresponding to an Arc of $16^{\circ} 15'$ the Latitude of Banda.

Q. E. Id.

PROBLEM VI.

Given the Sun's declination - - - - - $1^{\circ} 11'$ North.

The length of the Madhyama Chya, or mid-day shadow due to that declination, - - - - - $3^{\circ} 14'$ (*)

Wanted the Acsha Bagahs (Latitude) and Natansa (Zenith distance.)

A

Proceeding on the same principles as in Problem II, the Madhyama Carna, the Hypotenuse of Shadow due to $1^{\circ} 11'$ declination North, will be

$$\sqrt{12^2 + 3.14^2} = 12^{\circ} 26'$$

B

Then say

As Madhyama Carna, - - - - - $12^{\circ} 26'$

To Chya or Shadow, - - - - - 3.14

So Radius, - - - - - $3438'$

To - - - $\frac{3438 \times 14}{1226} =$ - - - $604'$

The Zenith distance
or Natansa.

The Natajya, or Sine of Zenith distance at noon, which corresponds to an Arc of $15^{\circ} 4'$.

C

The Acsha Bagahs
or Latitude.

In the present case as the Sun at noon, is South of the Zenith, and as his declination is North;

(*) Vide Scholium for the manner of determining this quantity.

their sum $15^{\circ} 4' + 1^{\circ} 11' = 16^{\circ} 15'$, gives the Altitude of the Pole, as before determined.
(Prob. V.)

SOLUTION.

When the Altitude of the Pole and the Sun's Declination are both given, the Madhyama Chaya or mid-day shadow for any day in the year may be found by reversing the foregoing rule.

PROBLEM VII.

Given the Sun's Zenith distance at noon	-	-	-	-	15° 4' S.
The Altitude of the Pole	-	-	-	-	16 15 N.
The Palabah	-	-	-	-	3° 30'
The Vishama Carua or Hypothenuse	-	-	-	-	12 30

Wanted the difference between the Palabah and Madhyama Chaya on the day when such Zenith distance was observed at noon, and the Declination, or Cranti Bagahs.

Madhyama Chaya for any day in the year, and Declination or Cranti Bagahs.

A

The Zenith distance being South and the Latitude being North, take their difference.

Zenith distance	-	-	-	-	15° 4' S.
Latitude	-	-	-	-	16 15 N.
Sun's Declination	-	-	-	-	1 11 N.

B

Then say

As Madhyama Cotijya, or Cosine of the Sun's Zenith distance at noon $15^{\circ} 4'$ - 3320

To Vishama Carua $12^{\circ} 30'$ - 12° 30'

So Sine of Sun's Declination equal to its Arc $1^{\circ} 11'$ - 71'

= To $\frac{12.50 \times 71}{3320} = 0^{\circ} 16'$ which quantity subtracted from the Palabah - 3° 30'

- 0 16

gives - 3 14 the

Madhyama Chaya or mid-day shadow for the day on which the Zenith distance was observed.

Q. E. In.

PROBLEM VIII.

Given the Altitude of the Pole	-	-	-	-	16° 15' N.
The Sun's Declination	-	-	-	-	1 11' N.
The Palabah	-	-	-	-	3° 30'

Wanted the Sama-Mandala Chaya, or length of the shadow when the Sun is East or West.

Sama-Mandala Chaya.

A

Say : As Sine Declination $1^{\circ} 11'$ - 71'

To Sine of Latitude $16^{\circ} 15'$ - 282'

So height of Sanku 12' or - - - - - 720'

To $\frac{552' \times 720'}{71'} =$ - - - - - 162' 36' the Sama-

Mandala Carna or Hypotenuse of the Shadow. (*)

B

Lastly, the Sama-Mandala Carna being thus found to be 162' 36'; and the height of the Sanku being always 12' or 720', we have $\sqrt{162.36^2 - 720^2} = 162' 2'$, the Sama-Mandala Chaya sought.

Q. E. Id.

PROBLEM IX.

Given the Sun's Declination - - - - - 1' 11' N.

The Palabah - - - - - 3' 30"

Wanted the Chara, or Ascensional difference.

A

Say first : As height of Sanku - - - - - 12' 0"

To the Palabah - - - - - 3 30

So Sine of Sun's Declination 1' 11' - - - - - 71'

To $\frac{3.50 \times 71}{122} =$ - - - - - 21'

the Chetijya.

B

Then : As Cosine Sun's Declination 1' 11' - - - - - 3436'

To Chetijya above found - - - - - 21'

So Radia - - - - - 3438'

To $\frac{21' \times 3438'}{3436} =$ - - - - - 21'

the Sine of the Ascensional difference sought, which does not differ sensibly from its Arc.

Q. E. Id.

PROBLEM X.

Given the Altitude of the Pole - - - - - 16' 15'

The Sun's Declination - - - - - 1' 11' N

Wanted the Sun's Altitude at 10 dandas before and after noon.

(*) SCHEMUM.

The same result may be obtained by the following Cases:

As Sine of Declination 1' 11' - - - - - 71'

To Cosine of Latitude 16' 15' - - - - - 3293

So Palabah - - - - - 32 30v

To $\frac{3293 \times 32.30v}{71'} =$ - - - - - 162 36v, the same

as before.

The Chara or Ascensional difference.

PREPARATION.

Of 16° 15' the Sine is 262'	.	.	.	.	Cosine	3299'
Of 1° 11' " 71'	.	.	.	.	"	3435
10 dandas answer to an Arc of 60° (*) whose Cosine is	.	.	.	.		1719'

A

Say As Cosine Latitude	.	.	.	.	.	3299'
To its Sine	.	.	.	.	.	262'
So Sine of Declination	.	.	.	.	.	71'
To $\frac{262' \times 71'}{3299} =$	.	.	.	.	.	3' Sine of
the Chhetijya. (†)						

B

As Cosine Declination	.	.	.	.	.	3435'
To Chhetijya	.	.	.	.	.	3'
So Radius	.	.	.	.	.	3438'
To $\frac{3 \times 3438}{3438}$	.	.	.	.	.	3' Sine of
the Charajya.						

C

Add the Cosine of the Hour Angle to the Charajya	.	.	.	.	.	1719'
						3
You have the Wutrajya	.	.	.	.	.	1722'

D

Then say : As Radius	.	.	.	.	.	3438'
To the Wutrajya	.	.	.	.	.	1722'
So Cosine Declination	.	.	.	.	.	3435'
To $\frac{1722 \times 3435}{3438} =$	.	.	.	.	.	1721'

the Chadam.

E

As Radius	.	.	.	.	.	3438'
To the Chadam	.	.	.	.	.	1721'
So Cosine of Latitude 16° 15'	.	.	.	.	.	3299'

(*) Table XXXI.

(†) The Hindus instead of saying : As the Cosine of the Latitude : to its Sine, always say : As the Sine of Gnomon : To the Vishama Chaya, or Equinoctial Shadow, &c.

To the Yesta Sanku (*)

$$\frac{1721 \times 3439}{3439} =$$

1632'

or Sine of the Sun's Altitude, whose Arc is 28° 45' at 10 dandas before and after noon.

Q. E. I.

PROBLEM XI.

Given the Altitude of the Pole

16° 15'

The Sun's Declination

1 11' N

The Sun's Altitude

28 45

The time before or
after noon.

Wanted the time before or after noon.

N. B.—The present proposition is only the converse of the preceding one.

A

Say: as Cosine Latitude: Sine Sun's Altitude :: So Radius: to the Chadam

$$\frac{1659 \times 3438}{3439} = 1721'$$

B

As Cosine Declination: to the Chadam :: So Radius: to the Wotrajya.

$$\frac{1721 \times 3438}{3439} = 1722'$$

C

As Cosine Latitude: to Sine of the same :: So Sine of Sun's Declination: to the Cabetijya.

$$\frac{668 \times 71}{3439} = 3'$$

D

As Cosine Declination: to the Cabetijya :: So Radius: to the Charajya.

$$\frac{5 \times 3438}{3439} = 3'$$

E

The Wotrajya (B) minus the Charajya (D) gives the Cosine of the Hour Angle from noon, i. e. 1722'—3'=1719'; the Arc answering to which is 60°; and this Arc answers to 10 dandas (†.)

Q. E. Id.

(*) The Sine of the Sun's Altitude being called the Yesta, its Cosine is termed the Yesta Drog Jya; which explains the following analogy.

As Yesta Drog Jya

To Yesta

So Yesta Chaya or length of Shadow

To height of the Sanku

whose Hypothenuse is sometimes called Yesta Garas,

(†) Table XXXI.

NOTE.

1^o By help of the preceding Problems if the Altitude of the Pole be given, the *Ravi Sayana*, or Sun's Longitude reckoned from the Equinoctial point may be found from day to day, by means of the *Madhyama Chaya* or Meridian shadow.

2^o The length of the shadow being known (Problem VI), the Sun's Zenith distance may be found.

3^o The Meridian Zenith distance, and the Latitude of the place being known, the Sun's Declination may be found (Problem VII.)

4^o The Obliquity of the Ecliptic being always 24°, and the Sun's Declination being given, the Hypotenuse or Arc of the Ecliptic between the Sun and Equinoctial points, called the *Ravi Sayana*, is easily found.

SECTION II.

In order to determine the length of the *Savan* day, or the true time from Sun rise to Sun rise, in Sydereal time for every day in the year, we must establish: 1^o What the Sun's Declination is when his Longitude (*Ravi Sayana*) is I°; II°; and III°.—2^o The *Lagna*, or its Right Ascension when his Longitude is in the said points of the Ecliptic.—3^o The *Agra* or Amplitude of the Sun under the same circumstances.—4^o The *Chara* or Ascensional difference under do.—5^o The *Ullagna*, or Oblique Ascension of each Sign of Longitude counted from the Equinoctial points, for the particular Latitude which is to be computed for.

The length of the *Haraut Savan* day.

1^o

To find the Sun's Declination when his Longitude is I°; II°; and III°.

Sun's Declination,
1st, 2d and 3d Signs.

DATA.

Obliquity of the Ecliptic (constant)	.	.	.	.	24°
Its Sine, or <i>Paramapa-Uramojga</i>	.	.	.	.	1397'
Cosine do.	.	.	.	.	3140'
The Sine of 30° or I° the <i>Yekajya</i>	.	.	.	.	1719'
of 60 II the <i>Dunjaya</i>	.	.	.	.	2973'
of 90 III the <i>Trijaya</i>	.	.	.	.	3438'

N. B.—In order to save useless repetitions, it is to be understood that any expression given thus $\frac{1119' \times 1397'}{3138} = 698'$ implies the *Triranica* and means: As Radius 3438: to Sine 30° 1719:: So is Sine Obliquity 1397': to 698' the Sine of the Declination sought, which in the present case answers to an Arc of 11° 43', whose Cosine is 3366' the Declination due to I Sign or 30°.

$$\frac{2973' \times 1397'}{3438} = 1211' \text{ the Sine of the Declination due to } 20^\circ 33'$$

II Sign or 60°.

And for the III^d or 90th the greatest Declination being 24th its Sine is 4137

And Cosine 3140

DECLINATION.

Signs	I						Sine.
	II	}	{	11	43	-	698
	III			80	23	-	1211
				24	0	-	1397

2^d

To find the Lagus or Right Ascension under the foregoing circumstances.

FORMULA.

As Cosine of Declination

To Cosine Obliquity of Ellipse

So Sine Yekajaya, Doojaya, &c. or Longitude I, II or III^d

To Sine of Right Ascension.

For I Sign.

$$\frac{3140 \times 1319}{3300} = 1204 \text{ the Sine of the Right}$$

Ascension, whose Arc is 27th 50th

For II Signs.

$$\frac{3140 \times 2978}{3300} = 2907$$

the Sine of Right Ascension, whose Arc is 57th 43th

For III Signs.

We have of course 3438 (equal to Radius) 90th

Hence, Lagus calas, or minutes of the Equator answering to each Sign respectively.

Signs	I					
	II	}	{	1670	=	27 th 50 th
	III			1795	=	57 th 43 th — 27 th 50 th
				1935	=	90 — 57 th 43 th

3^d

Sun's Agra, or Am-
plitude for Da.

For the Sun's Agra, or Amplitude, under the same circumstances.

FORMULA.

As Cosine of Pole's Altitude (15th 4th Madras)

To Sine of Sun's Declination A. 1st

So Radius 3438

To Agraajya or Sine of Amplitude.

For I Sign.

$$\frac{3438 \times 3438}{3438} = 715 \text{ the Sine of the Sun's}$$

Amplitude, whose Arc is 12th 1st

For II Signs.

$$\frac{1711 \times 3438}{3316} = 1743' \text{ the Sine of Am.}$$

plitude, whose Arc is 21° 12'

For III Signs.

$$\frac{1397 \times 3438}{3348} = 1434' \text{ the Sine of Am.}$$

plitude, whose Arc is 21° 40'

Hence, the following Sun's Agras,

Signs	I } II } III }	{ 12° 1' . 21 12 . 24 40 .	Sines, 716 1348 1434
-------	----------------------	-----------	----------------------------------	-------------------------------

3e

To find the Chara, or Ascensional difference, under the same circumstances.

Sun's Chara or Ascensional difference for Do.

FORMULA.

As Cosine Declination (Art. I)

To Sine of Pole's Altitude (13° 4')

So Sine of Agra (Art. 3)

To Sine of Chara, or Ascensional difference.

For I Sign.

$$\frac{716 \times 776.4}{3390} = 165' \text{ the Sine of}$$

Chara, whose Arc is 2° 45'

For II Signs.

$$\frac{1348 \times 776.2}{3300} = 326' \text{ the Sine of Chara,}$$

whose Arc is 4° 45'

For III Signs.

$$\frac{1434 \times 776.2}{3300} = 331' \text{ the Sine of Chara,}$$

whose Arc is 5° 31'

Hence, the Calas or minutes of the respective Ascensional differences are,

Signs	I } II } III }	Prathama Chara Cumda { 2° 45' = 165'	Cosine,
		Madhya Chara Cumda { 4° 45' - 2° 45' = 121'	
		Antera Chara Cumda { 5° 31' - 4° 45' = 45'	

4e

To find the Ullagna, or Oblique Ascension of each Sign of Longitude for any particular place, The Ullagna or Oblique Ascension,
which let it be Madras.

circumference of the Equator; the above motion 42cal. 41vic. in Oblique Ascension may be considered as pranacalas, which therefore dividing by 6, gives 8vic. 1,6pra. (*)

The length of the Saran day from Sun rise to Sun rise is, therefore,

Dandas.	Vicinas.	Pranacalas.
60	8	1,6 Syderal time.
60		

To find the length of the artificial day, or time of the Sun being above the Horizon.

Length of artificial day.

A

We have found in the preceding article that the length of the Bhumi Saran day on which the Luni-solar year Cali yugam began, was 60° 8' 1,6", Syderal time, one fourth part of which is 15° 2' 0,4", or 15° 2' 4".

B

For the Sun's Declination on the same day.

Given the Sun's Ravi Sayana	-	-	-	-	0° 1' 20' 44"
Whose Sine is	-	-	-	-	87'
Obliquity of Ecliptic 24° and Paramapa-Cramajya	-	-	-	-	1397'
Say: As Radius	-	-	-	-	3438'
To Sine Ravi Sayana	-	-	-	-	87'
So Paramapa-Cramajya	-	-	-	-	1397'
(Sine of Obliquity)					
To Crantijya	$\frac{87' \times 1397'}{3438}$	=	-	-	35'

the Sine of the Declination sought, equal to its Arc.

C

For the Sun's Chari, or Ascensional difference.

1 ^a			
Data—		Sine.	Cosine.
The Pole's Altitude	13° 4'	777'	3348'
Sun's Declination N.	35'	33'	3437'
Say: As Cosine Polar Altitude	-	-	-
To Sine of the same	-	-	-
So Sine of Sun's Declination	-	-	-
To	$\frac{777' \times 33'}{3348}$	=	-
			8'

the Chantijya; which gives only a first approximation.

(*) To convert the 49 calas, 41 vicinas (in degrees) into time, we have for the calas $\frac{49}{10} = 4\frac{9}{10}$ p, and 60: 41 :: 10: 8. Hence the time would be 8v 1,6p.

	24	
As Cosine Sun's Declination	-	3437'
To Chetijya	-	8'
So Radius	-	3438'
To	$\frac{8' \times 3438}{3437} =$	7'

the Charajya, or Sine of the Ascensional difference sought.

Hence the Sun's Chara on the first day of the year Call yug 4923 was 7', which corresponds to 1 vig. 10 parts of time nearly. (*)

D.

For the Dinarda, and Ratri Arda.

Because the Sun's Declination is North—To the 4th part of the Savan

day (A)	-	-	-	-	15° 2' 4"
Add the time of the Chara (C)	-	-	-	-	+ 1 10
Half the day.	Dinarda, or half the day	-	-	-	15 3 14
	And	-	-	-	15 2 4
		-	-	-	- 1 10
Half the night.	Ratri Arda, or half the night	-	-	-	15 0 54

CONCLUSION.

The day. The artificial day, or Bhumi Savan dina, which opened the Luni-solar year Call yugam 4923, was, therefore,

	$2 \times 15^{\circ} 3' 14'' =$	-	-	-	30° 6' 28"
The night.	And the artificial night				
	$2 \times 15^{\circ} 0' 54'' =$	-	-	-	30 1 48

COROLLARY.

	Hence if from $60 + 15^{\circ} =$	-	-	-	75°
	We subtract the Dinarda	-	-	-	15 3 14
Time of Sun rising.	Time of Sun rising at Madras on the given day,	-	-	-	59 56 40
	And if we add thereto the duration of the artificial day	-	-	-	30 6 28
Time of Sun setting.	The time of Sun setting on the same day, $(60^{\circ} - 60^{\circ}) =$	-	-	-	30 3 14

It will be readily perceived that these resolutions differ materially from those procured by European Astronomy, which is to be particularly ascribed to the defective Longitude assigned to the Sun in the Indian Calculus.

ARTICLE 9.

Having thus expounded the doctrine of Hindu Gnomonics, we are now to apply it to the reduction of the end of the Amavasya Tithi calculated for Lanka in the preceding article, to any other Meridian or Latitude; and I shall select for that purpose, those of Madras, its *Acsha Bagahs* being $13^{\circ} 4'$, *Desentara* in time $47^{\circ} 4'$ East of Lanka: and *Palabah* $2^{\circ} 46,8''$.

For this we are to correct the Sun and Moon's Suta Graha, or true places in the Indian Zodiac, as found at page 88, for midnight at Lanka, to what they were when it was midnight at Madras.

Reduction of the end of the Amavasya Tithi at Lanka to any Meridian or Latitude.

DATA.

☉'s Suta Graha at true midnight at Lanka on the 12th Poongoni	-	11° 11' 36" 19"
☉'s " Gati or true motion	-	59 26
☾'s Suta Graha on Do.	-	11 17 51 22
☾'s Do. Gati	-	14 1 54
Desentara in time	-	47° 4'
Acsha Bagahs	-	13° 4'
Relative motion	-	13° 2' 28"

12th of Poongoni at true midnight at Lanka.
Thus complete.

A

For the Sun's place on the 12th Poongoni 4923, reduced to the Meridian of Madras.

Say : 60 guddias : $59' 26'' :: 47^{\circ} 4' : \frac{59\ 26 \times 47\ 4}{60g} = 46''$, and as the Longitude of

Madras lies East of Lanka, this quantity is *subtractive*.

Sun's true place at Lanka	-	11° 11' 36" 19"
Subtract motion during $47^{\circ} 4'$	-	46"
☉'s Suta Graha on the same day at midnight at Madras	-	<u>11 11 35 33</u>

B

For the Moon's place, reduced to the same Meridian.

The Moon's true motion on the given day was $14^{\circ} 1' 54''$, therefore say

: 60' : $14^{\circ} 1' 54'' :: 47^{\circ} 4' : \frac{14\ 1\ 54 \times 47\ 4}{60g} = 11' 0''$, being the Moon's progress in

the given time, which, as the Moon was proceeding from the Sun, is *subtractive*.

☾'s Suta Graha at Lanka	-	11° 17' 51" 22"
Subtract	-	11 0
Moon's Suta Graha at midnight at Madras	-	<u>11 17 40 22</u>

C

For the Sun and Moon's true distance.

☉'s Sputa Graha	-	-	-	-	-	11° 11' 35" 33" (A)
☾'s Do. Do.	-	-	-	-	-	11 17 40 22 (B)
Subtr. Area Indee Graha at Madras	.	.	.	.	.	<u>6 4 49</u>

D

For the time due thereto, say

$$: 13^{\circ} 2' 28" \text{ (Rel. mot.)} : 60^{\circ} :: 6^{\circ} 4' 49" \text{ (C)} \frac{60 \times 6^{\circ} 4' 49"}{13^{\circ} 2' 28"} = 27^{\circ} 58' 27"$$

time before midnight when the conjunction occurred.

Therefore subtracting from mean midnight	-	-	-	-	-	a. m. p. 48
Time of conjunction after mean Sun-rise at Madras on the	-	-	-	-	-	27 58 27
12th Poongoni,	-	-	-	-	-	<u>17 1 33</u>

E

For time after true Sun rise.

We have found at Section II of Cosmionics (page 106), that the Sun rose
on the 12th of Poongoni, at Madras, at

	a. m. p.
	50 56 46
	<u>60</u>
Equation of time	0 3 14 additive.
Time of conjunction after mean Sun-rise by present operations	17 1 33
End of Amavasya Tidhi	<u>17 4 47</u>

True time of conjunction after Sun rise under the Meridian and Latitude of Madras.

or instant of conjunction after true Sun rising, being the end of the 30th, or Amavasya Tidhi of the Lunar month *Phalguna* of the 4923d year of the Cali yug, and the beginning of the *Prathama* or 1st Tidhi of *Chaitra* of the 4924th year current, under the Meridian and Latitude of Madras.

And as the said *Prathama* Tidhi began after Sun rise on the 12th Poongoni, it is to be coupled with the 13th of the said Solar month, as may be seen in the Skeleton of the Panchangum, page 67.

I shall close this article with a remark of Audi Seshaya Sastra.

Some of the Moon's Equations not considered in this process.

In the computation of Eclipses wherein the Elements must be rigidly computed, the Moon's place is subject to other Equations, which need not be considered in the construction of the common articles of the Panchangum, where the resolution of the end of the Tidhis, and disposition, and duration of the months and years, are principally considered. In the Solar or *Vakiam* process, of which a general account will be given in the second part of this Memoir, all the Equations which have been theoretically accounted for in the preceding articles, are computed by means of Tables where, in some cases, two or three are blended together, so as to be quite undistinguishable.

Thus for instance, what the Tamuls call the *Arca Bahoota phala*, *Desantara*, and *Deerjaphala Samskara*, which are to account for the difference between mean and true time, of Longitude and Latitude, as these circumstances affect the Moon's place at a given instant and spot on the surface of the Earth, they compute together under the general designation of *Desantara Samskara*, or Equation of Longitude, so that the vast majority of those who use these Tables and processes, are absolutely unable to give the least account of their construction.

How the Tamil Kalendar makers compute some of their Equations.

Whatever process is followed, however, these reductions are very long and tiresome. The preceding investigation of Hindu Gnemonics has enabled me to dispose rapidly of the latter part of the last Problem, but the reader will have perceived that, in order to reduce the end of a Tidhi, and consequently that of any month and year, from its time at Lanka to any other place arbitrarily proposed, requires more time than the utility of such a proposition deserves when it does not refer to some of the higher Astronomical Problems. In order not to fatigue uselessly his attention, I shall therefore dispense in future from carrying my computations further than Lanka, excepting in the last Example of all, where I propose giving an entire solution of the *Cahaya* or expanded month, which will occur in the 5055th year current of the Cali yug; answering to the 1886th from the birth of Salivahana, and to the Christian year 1963.

ARTICLE 10.

How to compute Seriatim all the Tidhis in the year, the end of the last Amavasya Tidhi of the preceding year being given.

We have been under the necessity of interrupting our progress in the construction of the Kalendar, for the sake of elucidating the various theories on which it is to be modified according to time and place: we shall now resume the original research, to show how the end of the successive Tidhis of the new year may be determined, from the resolution of the end of that which closed the preceding one.

The beginning of the 1st Tidhi in the year being computed, how to find all the rest.

We have seen that the Amavasya Tidhi which ended the year Cali yugam 4925, and commenced the 4924th, at Lanka, terminated after Sun rise on Poongoni 12th, (page 90) $16^{\circ} 14' 28''$

$$\begin{array}{r} \text{Add} \\ 1 \\ \hline 13\text{th} \end{array}$$

to which date we are to adapt the Elements already obtained.

For the Sun's apparent place on the 13th Poongoni.

☉'s Madhyama Graha on the 12th, (page 87)	-	-	11° 0' 26' 37"
☉'s mean motion in one day	-	-	+ 59 8
Madhyama Graha on the 13th	-	-	11 10 26 45
Place of Sun's <i>Mandooka</i> (Apogee) its motion insensible	-	+	2 17 17 18
Ravi Manda Kendra	-	-	3 6 51 33
			6
	Bhujah		2 23 8 27
Argument of Anomalistic Equation	-	-	83' [8' 27"
			507"

Proceeding as we have done before, we shall find the *Ravi Manda P'hala* $2^{\circ} 9' 38''$

And the <i>Arca Bhagábala</i>	$\frac{2^{\circ} 9' 38''}{360}$ (*)	+	23
			<hr/> 2 10 9
☉'s <i>Madhyama Graha</i> above found	-	-	11 10 25 45
			<hr/>
Ravi Sputa Graha, 13th Poongoni,	-	-	11 12 35 45
			<hr/>

For the Sun's true motion.

The Sun's apparent place.

Instead of deriving it as usual from the Tables, when computing *seriatim*, the Hindus take the difference of the Sun's Sputa Graha on the two successive days, because the increment or decrement of its Sputa Gati, (apparent motion) is comprehended in the *Arca Bhagábala* (page 88) as above applied (+).

The Sun's true motion.

We have consequently

Sputa Graha on the 12th Poongoni, (page 88)	-	-	11 11 25 10
Do. Do. 13th do.	-	-	11 12 35 45
			<hr/>
Ravi Sputa Gati, 13th Poongoni,	-	-	59 35
			<hr/>

For the Moon's true place on the 13th Poongoni.

A

First correct the Moon's mean place.

☾'s <i>Madhyama Graha</i> , 12th Poongoni	-	-	11 21 15 34
☾'s mean motion in one day	-	-	13 10 55
			<hr/>
<i>Madhyama Graha</i> , 13th Poongoni	-	-	12 4 20 9
			<hr/>

(†) *Arca Bhagábala* depending on the Sun's Anomalistic

Equation	$\frac{2^{\circ} 9' 38''}{360}$	=	4 45
☾'s Corrected Graha, 13th Poongoni	-	-	0 4 30 57
			<hr/>

(*) The regular process for resolving the *Arca Bhagábala* would be

$$: 360^{\circ} : 89^{\circ} 8' :: 2^{\circ} 9' 38'' \text{ (Anom. Equat.) } \frac{30^{\circ} 4' \times 2^{\circ} 9' 38''}{360^{\circ}} = 23''$$

the same result as that used in the text. The two processes seldom vary by 1". So that the short one may be used with all safety for general purposes.

(+) This explanation, as well as many others inserted in this work, were literally given to me by the Native *Sastra* whom I consulted on these operations.

(†) The regular process would be

$$: 360^{\circ} : 13^{\circ} 10' 25'' :: 2^{\circ} 9' 38'' : \frac{13^{\circ} 10' 25'' \times 2^{\circ} 9' 38''}{360} = 4' 45''$$

B

For the place of the Moon's Apogee on the 13th Poongoni.

Place of <i>Mandocha</i> on the 12th Poongoni	-	-	7° 4' 35' 55"
Motion of Do. in one day	-	+	6 41
Place of <i>Mandocha</i> on the 13th Poongoni	-	-	7 4 42 34
D's Corrected <i>Graha</i> (preceding article)	-	-	0 4 30 57
Chandra <i>Manda Kendra</i>	-	-	7 0 11 37
			6
Argument of Anomalistic Equ. <i>Bhojah</i>	-	-	1 0 41 37
			30 11 37
			697"

C

Chandra *P'hala* Table for 30' - 2' 30" 2

31 - 2 36 37

$$4\ 35 = 275''$$

For fractional part

1st diff. -	80°	::	697''	::	275 :	50' } 30° An. 2' 30" 2'
2d diff. -	360	::	-697	::	2' 30" 2' :	4 } 54
					54	— 2 32 40 Mun. P'ha.

Which subtract from Corrected *Graha*

D's *Sputa Graha* on the 13th. of Poongoni

0° 4' 30' 57"

0 1 58 1

The Moon's true place.

For Luni-solar distance.

☉'s <i>Sputa Graha</i> on the 13th Poongoni	-	-	11 12 35 46
D's do. - - do	-	+	0 1 58 1
Soob-vi-Arca Indoo <i>Graha</i>	-	-	0 19 22 16

the *Tidhi Sputa*, or Argument of the true *Tidhi* on the 13th.

How to find the end of the *Prathama Tidhi*, which began with the *Amavasya ending*, by means of that distance.

☉ and D's distance at midnight.

A

As the duration of a *Tidhi* is determined by the time that the Moon takes to run through 12° relatively to the Sun, we may have the Moon's true motion in one day, as we had that of the Sun, viz.

Mean's true motion.	☽'s Sputa Graha on the 12th Poongoni, at Lanca (page 89) —	11° 17' 51" 22"
	☽'s Graha on the 13th do. (page 111) —	+ 0 1 58 1
	☽'s Sputa Gati on the 13th —	0 14 6 59 and

Relative motion.

Relative motion.	☉'s Sputa Gati —	59 26
	VI-Arca-Indoo-Gati —	13 7 13

B

The distance on the 13th at true midnight at Lanca, was found

(preceding article) — 0° 16' 22' 16"

Subtract motion for a Tidhi — 0 12

Arc of excess at mid-
night.

Excess of motion over a whole Tidhi at midnight — 7 22 16

C

For time due to this excess, say

: as 13° 7' 13" (Rel. mot.) : 60 : 7° 22' 16" : $\frac{60 \times 7^\circ 22' 16''}{13^\circ 7' 13''} = 33^\circ 42' 31''$

To be retrenched from midnight at Lanca.

Say therefore — 45g
33 42 31End of the *Pratha-*
ma or *Padhyami*
Tidhi.End of the *Prathama* Tidhi — 11 17 29 after Sunrise, and beginning of the *Vidya* Tidhi, or 2d Chaitram, A. C. 4924 current.

NOTE.

Registering the Tid-
hi.As the *Vidya* Tidhi began on the 13th after Sun rise, it is to be coupled with the 14th of Poongoni, which is accordingly done in the Panchangam. (Vide page 67.) (*)

COROLLARY.

End of the *Vidya*
Tidhi.

As 7° 22' 16" had already been run through at midnight at Lanca on the 13th, if we take the same from —

12'
— 7 22 16
4 37 44Beginning of the
Tadya Tidhi.we shall have the Arc which the Moon has to describe from the Sun before marking the end of the *Vidya* Tidhi, and beginning of the *Tadya*, or third Tidhi : but in order to get the correct time due to the same, the Sun and Moon's relative motion for the 14th of Poongoni must be computed ; then the last proportion will hold good as before ; *et ceteris paribus*.

(*) Vide also description of the Siddhanta Chandra Panchangam, paragraph 10, page 12.

ARTICLE II.

Resolution of a Cihaya Tidhi, or expanded Lunar day.

It has been observed (para. 7, page 72), that whenever a Lunar Tidhi commences and ends on the same Solar day, the precept requires that it be expunged out of the Kalendar; so that when such a case occurs, there is a chasm of an unit between two successive Tidhis. As this case recurs, on a medium, once in 64 days, the Epoch of any one Cihaya Tidhi being known, any other (past or future) may be anticipated within a day.

The Tidhis computed independently.

In the present Example I shall assume, that a mean Cihaya Tidhi was due about the 8th or 9th Vaisacha of the current year Cm. 4924 and proceed to the resolution of the same, following still the precepts of the Surrish Siddhanta.

In what follows, I shall only give in detail what may be new to the reader; but the quantities, the resolutions of which have already been explained, will be given in the abstract. It would, however, be quite impossible to give an intelligible account of what remains unexplored of these processes, if repetition were entirely excluded; and on that account I claim the reader's indulgence for unavoidable prolixity.

I.

For the Sun's mean place on the 8th Vyassei complete.

We have found at page 87, that the Sun's Madhyama Graha on the 12th of Poongoni, Sydercal time, was $11^{\circ} 9' 26' 37''$.

A.

To find the number of Savan days between the 12th of the Solar month Poongoni, 4923, and the 8th Vyassei 4924.

	Days.	Number of Days to be computed for the 8th Vyassei.
By the Solar Kalendar the Sydercal month Poongoni counts	31	
Subtract	12	
	—	
	19	
Duration of all Chaitram (Kal.)	31	
Proposed date in Vyassei	7 complete	
	—	

Number of Savan days for which the Sun and Moon's motion is to be found — 57 days.

B. THE SUN.

Sun's mean place,	By Table XX, we have for 50 days	-	:	:	1° 19' 16" 48"
	7 "	.	.	.	0 8 53 57
					<hr/> 1 26 10 45
	Add Sun's Madhyama Graha, 12th Poongoni	.	.	.	11 9 26 37
	☉'s Madh. Graha, 8th Vyassai complete, 8th current (*)				<hr/> 1 5 37 22

C. THE MOON.

		☽'s place.				Apogee.					
☽'s Madh. Graha, 12th Poongoni (page 89)		11°	21'	15"	34"	-	-	7°	4'	35"	53"
By Table XXI, for 50 days	-	9	28	49	3	-	-	0	5	31	9
7 "	-	3	2	14	4	-	-	0	0	46	47
		<hr/>				<hr/>					
Mean place of Moon and Apogee.	Moon's Madh. Graha and Mandocha, 8th Vyassai complete; midnight at Lanka,	0	22	18	41	-	-	7	10	56	49

SECTION I.

A

Elements for the 8th Vyassai complete, A. C. 4924 current.

Elements.	☉'s Madhyama Graha	-	-	-	1° 5' 37' 22"
	☉'s Mandocha (motion insensible)	-	-	-	2 17 17 18
	☽'s Madhyama Graha	-	-	-	0 22 18 41
	☽'s Mandocha	-	-	-	7 10 56 49

Proceeding as before, these quantities will give us:

THE SUN.

☉'s Anomalistic Argument or Manda Kendra	-	-	1° 11' 39' 56"
" Anomalistic Equation or Manda P'hala	-	+	1 27 30
" Arca-Bahoota P'hala	-	-	" " "
☉'s true place or Spata Graha	-	-	1 7 5 6
" true motion	-	-	57 28

THE MOON.

☽'s Anomaly	-	-	5° 11' 22' 7"
" Bhaja, Argument of Equation	-	-	6 18 38 8 (+)
" Chandra P'hala, Anom. Equat.	-	-	1 37 17
" Arca-Bahoota Sumscara P'hala	-	-	+

(*) This would be marked the 9th in the Panchangam, which always gives the current day. But as the fraction of the *Margasa* for the 1st Vyassai is (Sunday) 55g. 10v. 10p. (so appears in the Calendar given at the head of this Memoir), the Civil account for all that month dates one day less, and is therefore put down 8th current.

(+) ☽'s mean place	0 22 18 41"
Place of Apogee	7 10 56 49
	<hr/> 3 11 21 52
	<hr/> 12
Manda Kendra	6 18 38 8

and

$$0^{\circ} 22' 18'' 41'' - 1^{\circ} 37' 17'' + 3' 14'' = 0^{\circ} 20' 44'' 38''$$

☽'s Sputa Graha at midnight of the 8th Vyassei complete, at Lanca.

☽'s true motion found as before $14^{\circ} 16' 10''$.

B

Hence for the resolution of the end of the Tidhi, we have the following corrected Elements.

At midnight	☽'s Sputa Graha	-	-	-	1° 7' 6" 6"	True distance 8th Vyassei complete.
at Lanca	☽'s do. do.	-	-	-	0 20 44 38	
					<hr/>	
☽ and ☽'s true distance	-	-	-	-	0 16 20 28	
					<hr/>	
At	☽'s Sputa Gati	-	-	-	0° 57' 28"	End of 8th.
Lanca	☽'s Do. Do.	-	-	-	14 16 19	
					<hr/>	
Soob.vi.Arca Indoo Gati or Relative Motion	-	-	-	-	13 18 31	
					<hr/>	

C

Resolution of the end of the Tidhi.

As the Moon moves through 12 degrees of her Synodical Revolution in one Tidhi, the Hindu Astronomers have found means of abridging the process by computing, first "How many complete Tidhis have elapsed in the *Bhaja*, or complement to 360° of the Sun and Moon's "Revolutions on the proposed day; and, secondly, by finding the time due to the remainder."

Shortening the process.

$$\text{Now having found this to be} \quad - \quad - \quad - \quad - \quad 0^{\circ} 16' 20' 28''$$

12

$$\text{Bhaja} = 11 \quad 13 \quad 39 \quad 32$$

$$\text{or} \quad 243^{\circ} [39 \quad 32]$$

1^o Say : As 12° : To 1 Tidhi :: 243° :

: $\frac{1 \times 243}{12} = 20$ Tidhis complete, with a remainder of $7^{\circ} + 39' 32''$ of the *Bhaja* unaccounted

Number of Tidhis
expired on the given
day.

for, but which shall be considered presently.

The quotient, which was found to be 20, shews that the Tidhi sought, is the 25th of the Lunar month Vaisacha complete, and as we have worked for the 8th Vyassei Solar time, also complete, that Tidhi is to be coupled with the said Solar day.

And on account of the division of the Lunar month into two *Pachams*, it is customary to register the same $28 - 15 = 13$ th Christmas Pacham; which is accordingly done in the *Panchan.* gum, page 67.

To proceed.

2^o As there were 20 complete Tidhis expired at the time for which the computation was made, the remainder, after division by 12 (viz. $7^{\circ} 39' 32''$) indicates a part of the 29th Tidhi (then current) which had expired, and in order to determine its end, or the beginning of the 30th Tidhi (which is always that of the conjunction)

Remainder to the
conjunction.

Say	.	.	.	.	.	.	From	12'
							Take	7 39 32
Arc due to what remained of the 29th Tidhi, in degrees, &c.							}	
at midnight at Lanka								4 20 28

D

For the time due to this Arc, considering that a great portion of the 29th Tidhi will fall on the 9th Vyassei, we require the true relative motion for that day, which, proceeding as before, will be found to be

Say therefore,

For the end of the
29th Tidhi,

: Relative motion $13^{\circ} 22' 26'' : 60'' ::$

Arc of complement $4^{\circ} 20' 28'' :$

: Time due to Arc from midnight at Lanka $\frac{60 \times 4^{\circ} 20' 28''}{13^{\circ} 22' 26''} = 19^{\circ} 28' 32''$

Add midnight 45

Subtract $64^{\circ} 28' 32''$
60

Time of 29th Tidhi ending after Sun rise on the 9th Vyassei, or beginning of the 30th $4^{\circ} 28' 32''$

Registering the Tidhi.

Thus, the 30th Tidhi of the Lunar month Vaisacha having begun *after* Sun rise on the 9th of the Solar month Vyassei, if nothing had intervened, should have been coupled with the 10th of the said month. The remainder of the Example will shew us, whether the case admits of that arrangement.

SECTION II.

A

For the end of the 30th or Amavasya Tidhi.

For the 30th or A-
mavasya Tidhi, being
an arranged one.

Proceeding as before, for the 9th Vyassei we shall find

At midnight	} ☉'s Suta Graha, 9th	.	.	.	.	1° 7' 44" 3"
at Lanka		☽'s Do. Do.	.	.	.	1 5 2 58
<hr/>						
☉ and ☽'s distance		.	.	.		0 2 41 5

Relative motion.

At Lanka	} ☉'s Suta Gati, 9th	.	.	.	.	57' 26"
		☽'s Do. Do.	.	.	.	14 19 52
Relative motion						13 22 26

B

For time due to distance.

Say	At relative motion	.	.	.	.	.	.	13° 22' 26"
	To one Saran day	.	.	.	.	.	.	60"
	So distance at midnight	.	.	.	.	.	.	2 41 5
To		$\frac{60 \times 2^{\circ} 41' 5''}{13^{\circ} 22' 26''}$	.	.	.	.	.	12° 2' 40"

After midnight at Lanka, which marks the true time of conjunction, and consequently the end of the 30th, or Amavasya Tithi. End of the 30th Tithi.

To express the same in Solar time, we have	-	-	45 ⁷
			+ 12 2 40
Time after Sun rise on the 9th	-	-	57 2 40
			60
The same before Sun rise on the 10th	-	-	2 57 20

CONCLUSION.

As the 29th Tithi ended at 4^h 23^m 50^s after Sun rise, and the 30th on the same day at 57^m 2^s 40^s, it is manifest that the whole of the 30th or Amavasya Tithi, was expended during the 9th of the Solar month Vyassat, and therefore, that it is a *Cakaya*, or *expunged Tithi*. It is accordingly left out of the Panchangum; but its name and duration are inserted in the margin. (*) There is, in consequence, no 30th Tithi registered in the column for the month Vaisacha (page 67.) Hence also the *Prathama Tithi* of the Lunar month Jath'ta, falls on the 10th Vyassat, Civil account; for (as has been said in the note at the foot of page 114.) it falls truly on the 11th Sydercal day current, but as Vyassat commenced at *night time*, its Civil beginning fell *one day later*, and hence the 11th Sydercal is only the 10th Civil day of that month. (Vide Skeleton of Luni-solar Kalendar, ibid.)

The *Cakaya* Tithi determined and left out of the columns of the Kalendar.

The case of the *Adigah*, or repeated Tithi, being resolved precisely like that of the *Cakaya*, I shall not detain the reader by any further example.

The same process applies to the resolution of the intercalary days.

I shall now take leave of the Surriah Siddhanta, and enter on the consideration of the *Vakiam* or Solar process.

(*) Oppadi or *Cakaya* Amavasya Tithi 52^m. 33^s. 50^s. the duration of that Tithi being 57^m. 2^s. 40^s.—4 23 50
—52 33 50.



PART II.

Of the Solar or Vakiam process.

The process of Solar Astronomy.

In the first part of this Memoir we have explained the principles on which all Indian Kalendars which (like that of the Tellingas) rest on the doctrines of the Surriah Siddhanta, are to be constructed. In the second we shall disclose the mechanism of the Solar Kalendar, which is much more extensively used in the Southern parts of India than the former, being that of all the countries where the Tamul language prevails.

Both Kalendars contain precisely the same Astronomical and Astrological articles, the only difference being, that the Elements from which the *Vakiam* Rules and Tables are constructed, are extracted from the *Ariah*, instead of the *Surriah* Siddhanta; and that the mode of proceeding for resolving the different Problems is totally different.

This process was, I believe, the first that became known to Europeans; and considering the nature of its *ostensible* Elements, and how concealed the *real* ones lie in its Tables and formulae from their original source, it is no wonder that the appearance of these, at the time of discovery, should have led, (even very scientific men) into the most extraordinary conjectures.

The most remarkable difference between the *Vakiam* process, and that of the *Surriah* Siddhanta, is, that the computations of the former are directly for the *apparent*, without previously obtaining the *mean* places of the Asters; and that these refer to the time of *Sun rising*, instead of *mean midnight*, as is directed in the *Surriah* Siddhanta.

In the *Key* to the *Madhyama Saura mana* we have given all that was necessary for the resolution of mean Solar, into European dates, therefore in the present division of the *Kala Sankalita*, we shall only attend to *Luni-solar* and *Solar* Hindu times.

The primary Elements of the Vakiam and those of the Ariah Siddhanta.

The Elements of the *Vakiam* process being those of the *Ariah* Siddhanta, the Solar year consists of $365^{\circ} 15' 31^{\circ} 15''$ as was used in the *Madhyama Saura mana* (*): the construction of

(*) According to that *Sastra* there are 1571917500 *Bhanti* Seven days (called *Yuga dina*) in a *Maha yug*, being 328 days less than by the *Surriah* Siddhanta. The Solar year is therefore $4111111111 - 205d. 13g. 31v. 15p.$ or 365d. 6h. 12' 30" in European time. Of periodical Revolution of the Moon relatively to the Equinoxes, there are 57753326 in a *Maha yug*, the Lunar periodical month is therefore $1511111111 - 27d. 11g. 17v. 38p. 20c.$ &c. or 27d. 7h. 43' 11" 23" &c. in European time. If from the number of periodical Revolutions of the Moon we subtract 4320000 *Revolutions*, we have 57753326 - 4320000 = 53433326 *Synodical* Revolutions of the Moon in a *Maha yug*; therefore $4111111111 - 20d. 31g. 50v. 3p. 4h.$ &c. or 22d. 12h. 44' 2" 16" &c. European time, is the mean duration of a mean *Synodical* Revolution of the Moon, according to the *Ariah* Siddhanta.

The Moon's Anomalistic Revolution is particularly noticed in the text, but in the Elements of the *Vakiam* it is taken to be 27d. 33g. 20v. Indian, and 27d. 13h. 20' European time.

that year is, therefore, to be used in the present process, instead of that which was given in the Skeleton for the *Siddhanta* Solar year 4924, at page 65; and the Roots of each of the 12 months, as well as the aggregate number of days in the concurring Lunations, will be,

Names of Solar months.	Types of Signs.	Roots of Ahargana for beginnings of Solar months.				Number of days in each month.		European dates of beginnings N. S.	Dom. Letter.	Lunations.	Aggregate time of Lunations.			
		n.	g.	y.	z.	Syde- real.	Civil.				d.	c.	y.	r. s.
Poongoni 1423	☾	(1)	59	51	28			11 March 1822	F	1	29	31	50	3 40
Chaitram 1424	☿	(4)	20	12	50	31	30	11 April 1822		2	59	3	40	11 20
Vyassai	♈	(0)	15	44	31	31	31	12 May		3	88	35	30	17 0
Asai	♉	(3)	39	56	32	31	32	12 June		4	118	7	20	22 40
Audi	♊	(0)	16	34	33	32	31	14 July		5	147	39	10	28 20
Auvai	♋	(3)	44	46	35	31	32	14 August		6	177	11	0	34 0
Paratnai	♌	(0)	46	56	36	31	31	14 September		7	206	42	50	39 40
Arpeti	♍	(2)	14	18	37	31	30	15 October		8	235	14	40	45 20
Cartiga	♎	(4)	8	25	38	30	30	14 November		9	265	46	30	51 0
Margali	♏	(5)	38	49	40	29	30	13 December		10	295	18	20	56 40
Tye	♐	(6)	50	42	41	29	29	11 January 1823	E	11	324	50	11	2 20
Mamsai	♑	(1)	26	58	42	30	29	10 February		12	354	22	1	8 0
Poongoni	☾	(3)	15	22	43	30	30	12 March		13	383	53	51	13 40
Chaitram 4925	☿	(5)	35	43	45	30	31	11 April						

N. B.—The Solar Ahargana may be found by means of Table XLVIII, part 2, of this collection, as follows:

for 4000 yrs.	-	-	-	-	1461034	43	20	0	Solar Ahargana beginning of 4924 of the Cali yug.
900	-	-	-	-	328732	48	45	0	
20	-	-	-	-	7305	10	23	0	
3	-	-	-	-	1095	46	33	43	
					1798168	29	3	45	
Subtract Sodhyam or Equation	—				2	8	51	13	
Solar Ahargana for the beginning of A. C. 4924					1798166	20	12	30	

With respect to the Luni-solar Ahargana, the Elements of the *Ariah Siddhanta* will give some difference from that which we found to proceed from those of the *Surriah Siddhanta*; but in this place, we can only account for that variation in a summary way. We shall, however, renew the full discussion of that subject in the Note where the method of resolving that Element by the Tables will be considered. (*)

(*) The Rule for resolving the Luni-solar Ahargana is precisely the same as that used with the Elements of the *Surriah Siddhanta*; and therefore need not be repeated, but the same may be found with much less trouble by means of Table XLIX.

Luni-solar Ahargana end of the year 4023 of the Cali yug.

It will be seen in the marginal note of the preceding page, that according to the Arish Siddhanta, a mean Lunation is $29^{\circ} 31' 30'' 5'' 40''$ &c. consequently that the Lunar year of 12 months consists of $354^{\circ} 22' 1' 8'' 2,6''$ &c. Now as we require the Luni-solar Ahargana for the end of the year 4023 of the Cali yug, it will be found that in this number of Solar years, there are 5074 Lunar years, and three Lunar months over, in all 60891 Lunar months, which, therefore, multiplied by one mean Lunation gives $29^{\circ} 22' 1' 4'' 2,0'' \times 60891 = 1798146'$ [$39^{\circ} 24' 28'' 53'$

$$\begin{array}{r} \text{And for the current day} \quad - \quad - \quad - \quad + \quad 1 \\ \text{The Luni-solar Ahargana sought} \quad - \quad - \quad - \quad 1798147 \end{array}$$

This Ahargana differs in appearance, one day from that resulting from the Elements of the Surriah Siddhanta, but in reality only $22^{\circ} 24' 31''$ or $8^{\circ} 57' 35'' 24''$ European time. It will be seen presently, that this variation is of no sort of importance, because the apparent position of the Sun and Moon elicited by any Ahargana and the Valiam Tables will soon shew, whether the Asters be within one day of the conjunction, or not; and in the latter case, the Ahargana must yield to the circumstance, and be fitted to the proper time.

For the Soota dina, or feria of last conjunction, we have as usual $7)1798147(256878$

with a remainder of $- \quad - \quad - \quad 1$ to be counted

from Thursday. The Soota Dina therefore, falls on Friday, and as the following Saturday was formerly found to fall on the 12th of the Solar month Poongoni complete of A. Cali yugam 4023, this Friday falls on the 11th of the same month, (also complete) which means the time of Sun rising on the 12th.

ARTICLE 1.

Of the Elements and their construction.

The Sun and Moon's apparent places in the Hindu Zodiac for apparent time at Sun rising at Lanka, are to be obtained by means of the following Elements and process.

1^o The Sun's place is determined by converting the number of months, days, gaddias, vigaddias, &c. into signs, bagas, calas, and vicalas; being that measure of time which the

Solar Ahargana	Years.	D.	S.	V.	P.	V.
17981604	4000	1417/87	55	39	43	50,0
(0) 1744545	200	212/30	17	0	29	0,0
33613	50	7087	20	22	40	32,0
(1) 35436	3	1083	6	3	24	7,8
18192	intercalations } 3 months	(0) 1744518	39	2	51	19,6
(2) 17715		(1) 25420	41	53	24	20,0
451		(2) 17718	50	56	42	10,0
(3) 254		(3) 354	52	1	8	2,6
110		(4) 58	25	50	17	0,6
(4) 22		1798146	39	24	28	53,0
23		+ 1				
		Luni-solar Ahargana sought = 1798147				

The Ahargana of the Arish or Surriah Siddhanta may be used indiscriminately.

Hindus, in a special sense, call *Saura* (*). In this account, all days and fractions are always equal to one another, a sign corresponding to one month, a degree to a day, &c.

Generation of the Elements.

2^o By equating (by means of a Table called *Yoghladi*, the XXVIIth, 1st part, of this collection) the Arc so expressed, into that really gone through by the Sun in the same space of time; of which Table and operation a particular explanation follows.

The Sun's place at his rising at Lanka.

3^o By finding the Sun's true motion from eight to eight days, or, approximatively, for every day by means of the same Table, part 1; and still more correctly by the second part thereof, if judged necessary.

His motion.

The Moon's apparent place is deduced for any proposed time, from her place at the beginning of the *Calī* yug. The rule includes at once her motion, and that of her Apogee; and the period when she completes a certain number of true Anomalistic revolutions in a known place of the Zodiac, affords means for finding how far, at any given time, she is advanced in a period of 248 days (called *Devaram*), which is taken to be equal to 9 of her Anomalistic revolutions; then, by help of another Table (the XXVIth of this collection), we know how much she takes to pass through each degree of her orbit, during the said period; and how far she is advanced at the proposed time in the Hindu Zodiac.

The Moon's place for the same instant.

On calculating the number of Anomalistic revolutions which have occurred from the origin of the *Calī* yug, to any assigned period, the Hindu Astronomers have determined that there were exactly 3785 Anomalistic revolutions of the Moon in 105052 mean Tiddis; from which they concluded that there were 27,9926024 mean Tiddis in one revolution; and as the mean Tiddi is to the *Bhumi* *Saran* day as $\frac{59c\ 3v\ 88p}{60}$, they concluded $27^{\circ} 33' 16'' 33^{\circ}, 62$ in natural days for the same. The period, however, which is used in the *Vakiam* process, differs a little from the above; being $27^{\circ} 33' 20''$; i. e. $3' 26'', 38$, or in European time $1' 12'', 4$ &c. longer.

Anomalistic revolution of the Moon.

The Moon's apparent place at Sun rise on any day at Lanka, is to be determined by means of five Elements, called *Vodam*; *Raza* *Gherica*; *Calanilum*; *Devaram*; and *Chandra* *Vakiam* *Dharmavankum*; which are generated as follows.

The Elements, for the Moon's apparent place, referred to Sun rising at Lanka.

1^o The *Devaram*.

Multiply one Anomalistic revolution of the Moon, $27^{\circ} 33' 20''$, by 9, and you have 248 days without a remainder, called a *Devaram*, when the Moon's place in Apogee is $0^{\circ} 27' 44'' 6''$ from the beginning of the Solar Sydereal Zodiac.

The *Devaram*.

(*) Vide Glossary at the end.

2. The *Calanilam*.

<i>Calanilam</i> .	Multiply one <i>Devaram</i> or 248°, by 12, and you have	2976°
	Add two Anomalistic revolutions of the <i>D</i> ,	53 6 40
	<i>A Calanilam</i>	3031 [6 40

neglect the fraction; and the Moon's place in Apogee is 11° 7' 31' 1". (*)

3. The *Raza Gherica*.

<i>Raza Gherica</i> ,	Multiply one <i>Calanilam</i> , or 3031°, by 4, and you have	12124°
	Add one <i>Devaram</i>	248
	<i>A Raza Gherica</i>	12372

and the Moon in Apogee is 9° 27' 48' 10".

4. The *Vedam*.

<i>Vedam</i> .	Multiply one Anomalistic revolution or 27° 33' 20", by 3, and you have	820°
	Multiply one <i>Devaram</i> or 248°, by 7	1736
	Add one <i>Calanilam</i>	3031
	Multiply one <i>Raza Gherica</i> or 12372°, by 129	1595988
	Add $\frac{1}{3}$ of Moon's Anomalistic revolution, neglecting the fraction	9 [11 6 40
	The sum is a <i>Vedam</i>	1600984

and the Moon's place in Apogee is 7° 2' 0' 7".

Let these four Elements be arranged in the inverse order from that in which they were generated.

	Number of Days.	Place of the Moon in Apogee.
One Vedam	1600984	7 2 0 7
" Raga Gherica	12372	9 27 48 10
" Colanilam	3031	11 7 31 1
" Devaram	248	0 27 44 6

The *Chandra Vakiam*
or *Dharmavanham*.

To deduce the *Chandra Vakiam Dharmavanham*, (which is the fifth Element of the Solar process) from the four preceding ones, it is supposed that the Solar and Luni-solar *Aharanant*, are previously known. Taking these as data, we have the following,

(*) There are two fractions arbitrarily neglected in the construction of these Elements, viz. 6g. 40v. in the *Calanilam*, which produce a difference of 16g. 4v. (in minus) in the *Raza Gherica*. In the *Vedam*, the neglecting of this fraction, together with 11g. 6v. 40p. on the third part of one Anomalistic revolution, will produce a very considerable Equation. Thus on 1 *Calanilam*

On 1 <i>Calanilam</i>	0g. 6g. 40v. 0p.
On 129 <i>Raza Gherics</i>	57 20 0 0
On 1-2d of 1 Anom. Revolution	0 11 6 40
Two Anomalistic Revolutions $2 \times 27d. 33g. 20v.$	51 37 46 40
	53 6 40 0
Difference on one Vedam. 2 Anomalistic Revolutions	+ 2 31 6 40

I could obtain no information as the reasons which have rendered the subtraction of that quantity necessary for having the Moon's true place at the end of a *Vedam*.

PRECCEPT.

For the Argument of the Moon's Equation.

- " Divide successively the Luni-solar *Ahargana* by 1 Vedam, 1 Raza Gherica, 1 Calanilam and
 " 1 Deraram, the remainder in days will be the *Chandra Vakiam Dhurmeranham*, which is the
 " Argument of Table XXVI, both for the Moon's true place and motion."

Elements for the Sun's Apparent place.

PRECCEPT.

- " 1^o Convert the number of months and days elapsed since the beginning of Chaitram γ ,
 " the former into the numeral of the last Sign gone through by the Sun, the latter into degrees,
 " which will answer to the time expired at the end of the proposed day.
 " 2^o If the month (whatever be the day computed for pending its duration) begins at day
 " time, deduct the guddias as calas, which had elapsed between Sun-rise and the time of his
 " entering a new Sign; the remainder will give his *Saura* place on the morning of the day on
 " which the Sydercal month commenced.
 " 3^o If the month begins at night time, add the guddias as calas which are wanting to com-
 " plete the night and begin the next day.
 " 4^o To find the Sun's Equation for one day by means of the *Yaghiadi* Table, divide by 3
 " the quantity given therein for the day itself; or (if it be not in the Table) for that nearest
 " below it, and the quotient will be the Equation of the Sun's true motion to 1' in a day, sup-
 " posed to be his true progress during 8 days.
 " 5^o Multiply the Equation thus found by the number of days you require in the interval of
 " 8 days, and the product will be the Equation required.
 " 6^o The Equations so obtained are *additive* from the beginning of Arpesi to the end of
 " Maussi, and *subtractive* from the beginning of Poengoul to the end of Paratasi."

As the preceding precepts are insufficient for a clear understanding and application of Table
 XXVI, the following article is intended for giving the reader a more distinct view of its
 construction.

ARTICLE 2.

Account of the Vakiam Tables.

- 1^o Of the *Chandra Phala* and *Sputa Gati* Table, being the first of the *Vakiam* process and
 the XXVIth of this collection.

The Argument of this Table is the *Chandra Vakiam Dhurmeranham*, or the remainder in days
 of the *Ahargana*, after division by the four Elements above described, 243 of these (equal to one
 Deraram) are registered in the first column.

The second column contains the *Chandra Phala*, or Moon's Equation, always to be added to
 her *Drusa*, and the third gives her true motion for each *Vakiam* day.

PRECCEPT.

Elements for the
 Sun's apparent
 place.
 Preccept.

Of the *Chandra*
Phala and *Sputa*
Gati Table.

The Moon's Equa-
 tion always addited.

The same always taken, for the Vakiam day found by the operation.

The Moon's motion to be taken for the next day when the conjunction is to come, or the Tithi ending.

The same to be taken for the day itself when the conjunction is passed, or the Tithi beginning.

The Equation is in all cases to be taken for the Vakiam day itself, such as indicated by the operation: but the Moon's true motion may be taken for that or the next day, according to the following rule.

If by the result of the operation it appears that the conjunction has not yet occurred, or (if during the course of the Lunar month) that the Tithi is at, or near its end, then the Chandra Gati, or true motion, is to be taken for the next day to that indicated by the Vakiam (or Argument).

But if at the time of Sun rising it appeared from the Sun and Moon's Longitudes that the conjunction had passed over, or that more than one half of the Tithi was expended, then in such a case, the Moon's true motion is to be taken as given in the Table for the day itself.

The Moon's mean motion, to which her true one is referred in Table XXVI, is 701 calas, or 13° 11' per diem.

Account of the Yoghiadi Table, being the second of the Vakiam process and the XXVIIIth of this collection.

OF PART FIRST.

1st Part of the Yoghiadi Table,

The account which was originally given to me of this Table was so very unsatisfactory, that it was a long time before I could understand its right application.

Independently of the precept which we have delivered in the preceding pages, it is to be understood that the calas or minutes given in the 4th column opposite to any day of the month in the division of which it is registered, represents the Equation of the Sun's motion in *plus* or *minus* to 1° for each day, for eight consecutive days. So that if opposite to the 1st day in the month Chaitram we find 11 calas, we are to understand that so many minutes will be the complete Equation due on the eighth complete day of the said month.

These 11 calas divided by 8, give a quotient of 1° 22' 30", which is the mean daily Equation used by common computers from the 1st to the 8th Chaitram complete.

But on the 9th day this Equation varies, for by the Table it gives 14 calas, meaning the aggregate Equation from the 8th to the 16th, both complete. During that interval the daily Equation will therefore be 1-8th of 14° or 1° 45'; and if we want that due to the 9th, it will be $11' + 1° 45' = 12° 45'$, the second member being added because the calas are increasing; but the whole Equation is subtractive, on account of the Sign — expressed in the column of months. Proceeding in the same manner, we shall find the Equation for the 16th Chaitram complete, to be $11' + 14' = 25'$ also subtractive.

Lastly, if the month Chaitram of the proposed year happened to be of 32 days and the Equation for its last day were required, we would add $11' + 14' + 16' + 17'$ (those due to 1st, 9th, 17th, 25th days,) = 58' for the quantity sought.

The Moon's true motion referred to 1° to a day.

But then on the ensuing day, because the Sun would enter a new Sign, all the foregoing Equations would be abandoned, and if it happened to enter the Sign *Veisha* ♄ at it's rising (which very rarely occurs), the Equation for that instant would be Zero. I shall illustrate the foregoing exposition by a few Examples.

The Equation equal to 0, when the Sun enters a new Sign at his rising.

EXAMPLE I.

Let it be required to find the Sun's apparent place on the 15th Chaitram of the 4924th year of the Cali yug current, at his rising at Lanka.

The Sun's place for 15th Chaitram A. C. 4924.

On the 1st Chaitram the Sun entered the Sign *Mesha* ♈ at 20° 12' 30" after Sun's rise (1st General Table), then

☉'s place, 1st Chaitram	0° 0' 0"
For 15 days complete	15 0 0

But as at his rising he was still in the Sign *Min* ♎, therefore we are to deduct the guddias as *calas* for 20° 12' 30"

☉'s Saura place, 15th Chaitram	0 15 0 0
	0 14 39 47

To find his Equation, the *Foghindi* Table gives for 8 days complete 11 *calas*, we want therefore for 7 days more; and finding 14' for 9th Chaitram, the 1-8th part of that quantity or 1' 45" is the daily Equation from the 8th to the 16th complete: therefore $7 \times 1' 45" = 12' 15"$, is the Arc to be added to 11 *calas*, before found; the sum amounting to 23' 15".

But we have retrenched from the Sun's Saura place 20' 13", on account of 20 guddias, 13 vig. (nearly), in the ratio of which we are to decrease the above Equation.

Now having found that the daily Equation from the 9th to 17th beginning, was 1' 45".

Say : 60° : 1' 45" :: 20° 13' : 35" and

Corrected Equation	23 15 0
☉'s Saura place above found	14 39 47

His <i>Sputa Graha</i> or true place sought	14 17 7
---	---------

EXAMPLE II.

The same for the 24th Audi complete of the 3724th year of the Cali yug.

The Sun's place 24th Audi 3124.

Let us take for data, that the Sun entered the Sign *Carcata* ♋ on the 1st Audi of the proposed year, at

After Sun rise—remains of the day	51° 34' 33"
Proceeding as before, say, 1st Audi	60
For 24 days complete	8 25 27
For the time wanting to Sun rise	3 0' 0"
☉'s Saura place, 24th Audi	24 0 0
	8 25
	3 24 8 25

The Table XXVII, part 1, for 8 days in Audi gives $24'$; for $16'$, $23'$; for $24'$, $22'$, and in the present case, as the Equation is required exactly for 24 days, all these calas being added together give $69'$ for part of the Equation sought.

But we have added, for $8' 25' 27''$ that remained of the day, an Arc of $8' 25'$ to the Sun's Saura place; the Equation must therefore be increased in ratio to the same.

As on the 24th Audi complete it was $22'$; 1.8th thereof is $2' 45''$, the daily Equation from the 17th to the 24th.

Say therefore : $60' : 2' 45'' :: 8' 25' 27'' :$	-	-	-	-	-	+	22
Equation above found	-	-	-	-	-	-	1 9 0
Corrected Equation	-	-	-	-	-	-	1 9 22
☉'s Saura place, 24th Audi complete	-	-	-	-	-	-	3 24 8 23
Sun's <i>Sputa Graha</i> sought	-	-	-	-	-	-	3 23 50 3

How to compute the
Sun's true diurnal
motion.

These two Examples will suffice to show, how the Sun's Saura place may in all cases be equated to his true one. There remains now to explain, how the Sun's daily motion is to be computed by means of the same Table, which however, has been in a great measure explained in the preceding article; for the mean daily motion for 8 days is obtained by dividing by 8, the calas registered opposite to the day next below the proposed one, the quotient being the Equation \pm to be applied to $60'$ for obtaining his true motion on the same day.

EXAMPLE 1.

Wanted the Sun's true motion on the 15th Chaitram 4924.

From Table XXVII, part 1, take the calas opposite to the 9th Chaitram, which are $14'$; 1.8th of which, $1' 45''$, is the Equation from the 9th to the 17th, being subtractive.

	-	-	-	-	-	-	60
	-	-	-	-	-	-	1 45
Uncorrected Sun's diurnal motion	-	-	-	-	-	-	59 15

and by the common Tamil Kalendar makers, this quantity is used indiscriminately as the true motion on any day during that interval.

Second. Differences
of the Sun's diurnal
motion.

But the few who aim at greater accuracy, take the second differences,—seldom, it is true, for equating the Sun's Saura to his true place, but frequently for finding his true motion on any specific day, the process of which is as follows :

Take the *calas* for the ensuing eight days, which in the present case will be those for the 17th Chaitram, viz. 16'; 1-8th of which is

Equation for the 9th, as above found

Difference

then 8' : 15' : 6' : 11" 22" &c. which as the *calas* are increasing, add to

Corrected Equation

Which subtract from

☉'s true motion on the 15th Chaitram

N. B.—In Table XXVIII that Equation is

Difference

on the 17th as the *calas* are 16', the Equation would be 2' and the Sun's motion exactly 58'.

ORIENTATION.

It is manifest that these corrections are equally applicable to the Equations for reducing the Sun's *Saura* to his *true* place; and it may appear singular that, whereas in equating the Sun's Longitude, the Tamul computers never omit to take into consideration that fraction of the day which marks the interval between Sun rising, and his entrance into a new Sign (whatever be the day of the month computed for) yet when calculating the Sun and Moon's distance and relative motion, they should entirely overlook these second differences.

Of the second Part of Table XXVII.

This part serves to find the Sun's Anomalistic Equation, and consequently the Solar and Luni-solar Arca Bhujabala, and the Sun's true motion for every day in the year, much more accurately than the first. Its Epoch is the beginning of the 4941st year of the Cali yug, answering to the 11th April 1839, when the place of the Sun's Apogee will be in 2° 17' 17" 20".

This quantity, which is to be found at the head of the fifth column, is the Supplement of the Sun's Anomaly to a complete Circle, on the 1st Chaitram, at the precise time when he will enter the Sign Mesha; and is therefore the Argument of his Equation for that day. The following quantities are the same for the beginning of the succeeding Solar months; but in using these, the positive and negative Signs must be taken as given in this Table, and not as exhibited in Tables XXII and XXIV, because the Argument of the former is always the Supplement of the Sun's Anomaly; and of the latter, the Anomaly itself; whereas in the 2d part of Table XXVII, it is either the one or the other, or their respective Bhujals to the Sun's Apogee or Perigee, conformably to the rules of the Sastras, a construction which saves the possibility of error.

2d Part of the Yugaadi Table.

Its Epoch A. C. 4940 complete A. D. 1839.

The Manda Kendra, or Argument for 1st Audi, column 5th, is $0^{\circ} 12' 42'' 40''$

Add Sun's motion for 20 days, because the Argument is increasing

In the 1st quadrant	-	-	-	-	10 42 45
Argument, 20th Audi	-	-	-	-	1 2 25 23
				or	32' 25' 23"

The Equation answering to which is

Difference between \odot 's true and mean motion

\odot 's true motion, 20th Audi

	-	-	-	-	1 10 47
	-	-	-	-	1 53
	-	-	-	-	50 8
	-	-	-	-	57 15
	-	-	-	-	57 14
N. B.—The same by Table XXVIII,	-	-	-	-	1
\odot 's Arca Bhagábala	-	11'	Difference	-	
J 's do.	-	2 37		-	

EXAMPLE III.

The same for the 18th Paratasi of the same year.

Argument, 1st Paratasi, column 5th	-	-	-	-	2' 13' 42' 40"
\odot 's mean motion for 18 days, Table XX,	-	-	-	-	17 44 35
To be added because the Argument increases in the 1st quadrant of Anomaly	-	-	-	-	3 0 27 16

Equation — $2^{\circ} 10' 32''$

3.365th of which is the \odot 's Arca Bhagábala — — 21

1.27th the Lunar Arca Bhagábala — — 4 48

Equation of true to mean motion — — 0

True motion, 18th Paratasi — — 59 8

which is the same as that given in Table XXVIII.

The same for the 18th Paratasi.

EXAMPLE IV.

The same for the 16th Margali of the same year.

Argument, 1st Margali	-	-	-	-	0' 17' 17' 20
\odot 's mean motion for 12 days	-	-	-	+	17 44 36
Of which take the difference	-	-	-	-	0 0 27 16
The Equation answering to this Argument	-	-	-	-	0' 3' 23"
\odot 's Arca Bhagábala insensible. J 's = 3'	-	-	-	-	
Equation of \odot 's true to mean motion	-	-	-	+	2 18'
	-	-	-	-	59 8

\odot 's true motion on the 16th Margali, which is at its maximum — 61 25

By Table XXVIII the same.

The same for the 16th Margali.

These operations are so obvious, that it would be a waste of time to carry them any further. They leave little doubt in my mind that Table XXVIII (which was communicated to me by a Native Astronomer) was computed by means of the 2d part of Table XXVII, though in some instances I have found a few seconds of difference.

N. B.—As the Sun's Apogee is supposed to move at the rate of 1' in 517 years, the latter Table may easily be fitted to any remote Epoch, by a common rule of proportion, all the Arguments being equally affected by its motion.

Of Table XXVIII.

This Table furnishes the Sun's true diurnal motion for every day in the year, and therefore requires no particular explanation. I suspect it to have been constructed by the person who communicated it to me, by means of the 2d part of Table XXVII. Be this as it may, as it saves the trouble of computing the Sun's true diurnal motion by either of the processes which we have formerly explained, I have thought it deserving to be inserted in this collection.

Table XXVIII, as well as the preceding one, supposes the Sun's Apogee in $2^{\circ} 17' 17'' 20''$, and on account of the slowness of its motion, will be sufficiently true for a great number of years.

Of Table XLVII. (*)

I profess to understand very imperfectly the construction of this Table, which was communicated to me by a Native Kalendar maker named *Sami Nada Sarkya*, who made all his computations with shells and tamarind seeds, but who, (though he used it constantly), could not give me the least account of the theories on which it was grounded.

There can be no doubt, however, both from the name given to the quantities registered in the 2d column, and from the manner of using it, that it accounts for the effects of the difference of Longitude on the Moon's apparent motion, between *Lanca* and some other place (+), which *Sami Nada* believed to be *Tanjore*, but in my opinion *Tricalare*, because that place lies not far from it, and is still reputed to be the seat of the sciences in these Southern parts of the Peninsula.

This Table, I was informed from the same source, is used indiscriminately for all places between Cape Comorin and Madras, though my informant acknowledged it would not do for *Mulayan*; by which he meant the Coast of Malabar. The lateness of the Epoch when this Table fell into my hands, prevented the possibility of my analyzing it as I could have wished: I am, therefore, compelled to confine myself to a mere explanation of its application, which I shall do in a solitary example; for as its results are confined to one particular spot, and as the

(*) The arrangement of the Tables having accidentally been disturbed, the present one, which should have been the XXIXth, is the XLVIIth, of this collection.

(+) The Sanguerote word for Terrestrial Longitude is *Duantare*; and for the Celestial *Sayana*.

Of Table XXVIII,
being the 2d of the
Yakiam process.

Of Table XLVII,
being the 4th of the
Yakiam process.

object of the present research is general, I shall, in the remainder of what I have to say on the *Vakiam* process, have recourse to these general methods, which though more operose, may be applied to any geographical position on the globe.

The Equations furnished by the Table under consideration (which is the 4th of the *Vakiam* process) are to be applied to the Moon's uncorrected place, such as it has been elicited by her *Drava*, and *Chandra Vakiam Phala*.

The *Desentara* calas or minutes, registered in the second column, are always additive, and to be taken for the month which *precedes* that for which the computation is made.

The *Andra viclas*, or odd seconds, registered in the third column, are for any day in the month itself that the computation is made for. They are to be used as multiples of the odd degrees, minutes and seconds of the Sun's true place, at Sun rising on the proposed day; the product of the degrees giving *viclas*, or seconds; that of the minutes, *terpavies* or thirds, and so forth, which implies a division by 60'.

This latter Equation is to be applied \pm to the Moon's uncorrected place, as indicated in the Table.

EXAMPLE.

Let the Sun's apparent place on the 24th Audi complete, be	3° 22' 59" 3
And the Moon's uncorrected place at the same instant	4 3 57 13
10 Add the Desentara calas for Audi II,	+ 7 0
20 The Andra viclas, for any day in Audi III (the month computed in) are	
+ 2°, and the odd degrees, minutes, &c. of the Sun's Longitude = 22° 59' 3"	
Multiply by	$\times 2$
Equation	45° 58' 6"
And on account of the 55° say	+ 46
3's place corrected for Desentara, 24th Audi	4 4 4 59

Of the Equation due to the difference between the Moon's true and mean motion.

There is a last Equation used by the Tamil Kalendat makers, of which *Sami Nada* could give me no other account, but that it was indispensable, and which I believe answers to the *Arca Bha. gubala*, though the process for eliciting it, bears not the least resemblance to any of the methods that we have hitherto seen.

In the Example which I have selected, there were, after division of the *Ahargama* by the respective Elements, 9 *Desarams*, and the *Chandra Vakiam Dhurmaranham* was 100, for which, by Table XXVI, the Moon's true motion is

Her mean motion being supposed to be	844
	791
	Difference 53

Application of the Desentara calas.

Of the Andra viclas.

Moon's place uncorrected.

Second correction supposed to answer to the Moon's Arca Bhogatala.

Difference of Moon's true and mean motions.

An Equation of $32''$
per Devaram.

Resolution of $2d$
correction.

Mer's place twice
corrected.

Now for each *Devaram* the precept directs an Equation of 32 *varparies* or thirds; therefore $9 \times 32'' = 288''$, which product multiply by as many units as there are in the difference of the Moon's apparent and mean motion, and this second product, which amounts to $288'' \times 53 = 4' 14'' 24''$, is to be applied \pm to the Moon's place once corrected, as her *true* is greater than her mean motion; and *vice versa*.

In the present case it will therefore be

Mer's place once corrected	-	-	-	-	4'	4'	4'	59''
Add Equation	-	-	-	-	+		4	14
Mer's place twice corrected	-	-	-	-			4	4 9 13

supposed to be her *Sputa Graha*, or apparent place at the instant of Sun rising on the 25th of Aadi, at the place computed for.

ARTICLE 3.

Resolution of the
last conjunction of
the year 4923 of the
Cali yug, reduced to
a given Meridian.

Resolution of the *Amavasya* which ended the 4923d Luni-solar year of the Cali yug, called *Brigya*; and preceded the commencement of the 4924th called *Chitrabhanu*, reduced to the Meridian of Trivalore, as is supposed.

A

We have found at pages 119 and 120, that the Solar and Luni-solar *Aharganas*, with the respective *Soota dina* for the end of the 4923d year of the Cali yug, were,

Solar Ahargana, 1st Chaitram 4924	-	-	-	-	1798166 20 12 30
Luni-solar do. 30th Phalgun 4923	-	-	-	-	1798147
The Solar Soota dina consequently	-	-	-	-	Thursday.
The Luni-solar do.	-	-	-	-	Friday.

1^o Divide the Lunar Ahargana successively by - 1 *Vedam* 1600984)1778147(1

1 Raza Gherica	-	-	-	-	11372)197163(15
					12372
					73443
					61800
1 Celanilam	-	-	-	-	3031)11583(3
					9093
1 Devaram	-	-	-	-	248)2490(10
					248
Chandra Vakiam Dhurmaraham	-	-	-	-	10

the Argument of Table XXVI.

2^o Multiply the analogous Longitudes by the respective quotients; viz.

1. Valsav	-	-	7'	2'	0'	7'	×	1	-	-	7'	2'	0'	7'
Rasa (berica)	-	-	0	27	48	10	×	15	-	-	4	27	2	53
Onaniam	-	-	11	7	34	1	×	3	-	-	9	24	31	3
Detaram	-	-	0	27	44	6	×	10	-	-	9	7	21	0
5's Drura											6	28	56	40
Equation for Chandea Vakiam 10 (Table XXVI)											4	7	58	0
Moon's place uncorrected											11	6	54	40

Moon's place uncorrected.

at the time of Sun rising at Lanka, on the 11th Poongoni ending, or 12th commencing; to be rectified hereafter.

B.

For the Sun's place.

We find by the Solar Aargana given at Article A, that the Sun entered the Sign Mesha ♈ when there had expired since the beginning of the Call yug - 1798166° 20' 12' 30"

Subtract abstract duration of the month Poongoni, Table III, — 30 20 31 2

Aargana, 1st Poongoni 4923 - - - 1798133 29 51 28

Aargana 1st Poongoni = 923

which shows that the Sun entered the Sign Min ♋ at night time; and that there remained to complete the night, and begin the day (60° — 50° 51' 25") 0° 8' 32"; which according to the precept delivered at page 123, article T, are to be added as *vicalas* and *tarparias* to the signs and degrees of his Longitude, in order to have that Element precisely for the time of his rising. Then to proceed,

Sun's Saura place, 1st Poongoni	-	-	-	11'	0'	0'	0'
For 11 days complete	-	-	-	11	0	0	0
Add for 3' 32", or say 9"	-	-	-	-	-	-	9

Sun's place uncorrected.

☉'s Saura place on the 12th Poongoni at his rising at Lanka 11 11 0 9

which to reduce to his apparent Sydereal place according to the precepts delivered at pages 119 and 120, we have by Table XXVII, part 1st, for the first 8 days in Poongoni — 2'; for the ensuing 3 days (from the 6th to the 17th) — 4'; and $\frac{1}{2}$ = 30' for one day; and from the 8th to the 11th there being 3 days, say $3 \times 30' = 1^{\circ} 30'$; which added to 2', gives — 3' 30' for the Equation sought; and as only 9" were added to the Sun's Saura place on account of what remained of the night when the Sun entered the Sign Min ♋, the second Equation adverted to at page 123, para. 3, is insensible. Hence

☉'s Saura place above found	-	-	-	11'	11'	0'	09"
Subtract Equation	-	-	-	-	-	3	30

Sun's place corrected.

☉'s Saura Graha, or apparent place at Sun rising at Lanka on the 12th Poongoni A. C. 4923. (*) 11 10 56 39

(*) As far as this step, the rule is the same whether we work for the Arva Bhagbhata by the 3d part of Table XXVII, or by the rule delivered at page 123, or if we mean to find the Sun's true position in the day computed for by Table XXVII or XXVIII, because these Elements have nothing to do with the preceding part of the operation.

With a view to establish the difference in the time of conjunction which would result from computing the same by means of an *Ahargana* (or sum of days) greater by one day than that which was obtained from the Elements of the Arianh Siddhanta, I have computed the *Ahargana* for the same conjunction as it would be by the Elements of the Surriah Siddhanta (Table XLIX, part 1), which is 1798148⁴, being *one day more* than that which we have used in the preceding computation. Now if we divide this new quantity by the four Elements, the remainder in days, or *Chandra Vakiam*, will be 11, instead of 10 that it was before; which 11 days used as the Argument of Table XXVI, for the Moon's Equation, and true motion, and then following the process to the end, as has already been shown, will give only a difference of 1' 42" in minus, in the ultimate result; (*) the reason of this being, that if one day more be taken in the *Ahargana*, you compute necessarily the Sun and Moon's apparent places for the morning *after* the conjunction; in consequence of which, at the end of the operation, you have to deduct the time due to the Sun and Moon's distance from 60 guddias, supposed to mark the time of Sun rising.—Whereas if you compute with one day less, you will find the Sun and Moon's apparent places in the morning *before* the conjunction, and therefore the time due to their distance must be *added*, instead of *subtracted*, to that of Sun rising on the day computed for. It is therefore immaterial which of the two *Aharganas*, by the Arianh or Surriah Siddhanta, are used in the *Vakiam* process.

ARTICLE 4.

In the preceding Article I have shown how the Sun and Moon's apparent places, their distance and time of conjunction are to be determined by certain Tamul Tables constructed for a particular spot in the Peninsula, which I conceive to be Trivalore. But as there should be a specific Desentara Table for every Meridian which is not that of Lanca, and as the object of this research is general, I shall dispense in future from using Table XLVII; and (excepting in the last example of all, where I propose resolving the time of the expunged month which will fall on the 3065th year of the Cali yug, reduced to the Meridian of Madras) all the rest of the computations will stop at *Lanca*. With a view to uniformity I shall therefore recompute the last operation from the point where it ceased to be common to all places, and by means of Table XXVII, determine the time of the last conjunction of the Luni-solar year 4923, as it would be reckoned at *Lanca*.

We have found at page 133, that the Moon's uncorrected place at Sun rising on the 12th Poongoni of the said year, at Lanca, was

	11' 5' 54' 40"
And the Sun's (page 133)	11 10 56 30

The same conjunction computed for Lanca.

(*) The quantity elicited by the last proportion, which is the time due to distance, was $\frac{43p. 34v. 19p.}{90}$

Time of Amavasya by Vakiam 11	16 25 48
-------------------------------	----------

which on account of his presence, and the comparative slowness of his motion, the Tamuls never correct for the difference of Longitude nor his Area Bhagābala. The last quantity is therefore, considered as his true or apparent place on the proposed day.

The Sun's Equation, direct motion, and Moon's Area Bhagābala computed by means of Table XXVII, p. 2.

But there remains to apply the Moon's Area Bhagābala to her uncorrected place, even for Lanka; and in order to be independent of Table XXVIII, which though sufficiently true for present time and for a great number of years past and to come, yet in process of time will be affected by the change in the position of the Sun's Apais, we shall compute the Sun's diurnal motion as well as the Lunar Area Bhagābala by means of Table XXVII, part 2.

That Table gives the Argument of the Sun's Equation on the 1st Poongoni, $+ 2^{\circ} 12' 42'' 49'$

☉'s mean motion for 10 days, Table XX,	9 31 22
for 1 do.	50 8

Manda Kendra, or Argument, on the 11th Poongoni complete	2 23 33 10
or	83 33 10

with which referring to Table XXIV, we find his Anomalous Equation $2^{\circ} 9' 44''$, marked additive in Table XXVII, part 2, and for the reasons given at page 127.

The Lunar Area Bhagābala is therefore $+ \frac{1^{\circ} 9' 47''}{2} = + 4^{\circ} 48' (^{\circ})$

With regard to the Sun's diurnal motion, the same Argument of Anomaly referred to the same Table XXIV, will give the Equation of the Sun's true to his mean motion $13'$; which as the day computed for falls before the 18th Poongoni, is still marked additive $50' 8''$

$+ 13$

The Sun's true motion on the 12th current is therefore $59 21$

For the Moon's corrected place and her distance from the Sun at his rising on that day.

☿'s uncorrected place	11 6 34 40
Her Area Bhagābala	+ 4 48
☿'s apparent place sought	11 6 59 28
☉'s do.	11 10 56 50
Distance	3 57 11

For relative motion.

☿'s Spata Gati	14 0 0
☉'s do. do.	30 21
Relative motion sought	13 10 29

(*) The Equation found at page 124, supposed to correspond to this, was $+ 4^{\circ} 21'$.

For time due to distance.

Say $15^{\circ} 0' 30'' : 60' :: 3^{\circ} 57' 11'' : 15' 4' 33''$

the end of the Anantarya Tithi after Sun rise at Lanka.

The same was found for a different place in the preceding article	16	26	39
Difference	1	37	31

True time of conjunction.

The end of the 30th Tithi of the Lunar month Phalguna of the year 4923, occurred therefore on the 12th of the Solar month Pousheng of the same year; and the *Prathama Tithi* or first of the Lunar month Chaitram of the year 4924, on the 13th of the same month of the Solar year 4923.

Q. E. Id.

The same conjunction computed by the Siddhanta process, was found to occur on the same day at $10^{\circ} 14' 28''$; the difference of the result is therefore $1^{\circ} 50' 5''$ and in European time $41' 2''$, a difference easily accounted for by the dissimilarity of the processes, and of the Elements used in each method. Nor is it to be believed that there may be found a greater degree of coincidence in the computations of different Tamil Astronomers, though using equally the Solar process; for independently of the Tables known to them all, they contrive others for their own private use, both for general and local purposes, which do not always agree; and occasion quarrels among them, which their ignorance of theory renders generally interminable.

ARTICLE 5.

Resolution of the two Anantarya Tithis which determine the Cshaya or expanded month in a double intercalary year.

In order to save a number of needless trials of years and months on which the discarded Lunar month may fall, I shall shew in the 3d part of this Memoir, how the Hindus foretell that accident, by computing the time when the Moon's Apogee lies in one of the Signs of the Solar Zodiac which corresponds to any of the three shortest Solar months of the year, and also when a mean *Adigah*, or Lunar intercalary month is due, in a particular Solar month where it cannot be introduced. For it will be seen, that the first of these cases is to be expected when the Moon in Apogee is in the same sign, degree, &c. as the Sun in Perigee; and the second when the Moon in Perigee coincides with the Sun in Apogee; and the probability of either occurring, is greater or less in proportion to the degree of coincidence of these Elements.

In the present article I shall be contented with the common trial of the three Cycles of 19; 111; and 160 years; and as the second is always the most probable one, considering that the last Cshaya occurred when the 4782d year of the Cali yug had expired (A. D. 1681 and 1693 Saka), I shall conclude that the next must fall when 4923 years of the Cali yug have elapsed; and lastly, as the month of *Margali* (Bengal *Paushia*) in the present position of the Sun's Apais, is the shortest month of the Solar year, I shall try the time of the two conjunctions, which may fall near to its beginning and end.

Registering of the last Anantarya Tithi of A. C. 4923 and of the Prathama Tithi of 4924.

Registration of the two Anantaryas which determine a Cshaya month.

Indication when a Cshaya month will occur.

The same of an Adigah month.

Resolution of the 1st Anantarya which determines a Cshaya month.

1.

For the first Amavasya.

A

The respective Aharganas for the beginning of Margali will be obtained as follows :

4923	Lunar.	4924	Solar.
Aharganas 30th Phalguna	1798117	1st Chaitram	1798166
Add 9 Lunations	265 46	Add number of days to the end of Chaitra (*)	245 18 37 10
	<u>1798112</u> 46		<u>1798112</u> 38 49 40
	1		1
Aharganas sought	<u>1798113</u>	2d Margali	<u>1798413</u>

Here the two Aharganas are alike, but of the *Soota dina* after division by 7, the remainder for that of the Sun must be counted from *Friday*, and that for the Moon from *Thursday*: Hence the 2d Margali falls on *Saturday*, and the nearest Amavasya, on *Friday*, which by the Kalendar will be found to fall on our 13th of December (page 119).

B

For the Sun's Anomalistic Equation and Moon's *Arca Bhagābala*, proceeding as in the preceding article, and with reference to Table XXVII, we shall find that the Sun's distance from his Perigee on the 2d Margali was $16^{\circ} 18' 12''$, and by Table XXIV his Equation — $37' 14''$.

The Moon's *Arca Bhagābala* is therefore $-\frac{87' 14''}{27} = -1^{\circ} 22''$.

C

The Moon's <i>Druva</i> will be	-	-	-	7' 25' 40' 46"
The Chandra Vakiam 28; and its Equation, Table XXVI,	0	8	26	0
Lunar <i>Arca Bhagābala</i> (B)	-	-	-	<u>8 5 6 46</u>
∂'s Sputa Graha on the 1st Margali	-	-	-	<u>- 1 22</u>
				<u>8 5 5 24</u>

complete, or 2d commencing at Sun rise at Lanka.

And Moon's true motion, Table XXVI, $722'$ or $12^{\circ} 2'$.

D

The Sun on the 1st Margali enters his 8th Sign (Kalendar, page 119) at $38^{\circ} 47' 40''$
60

Time to run to 2d Margali commencing $21^{\circ} 10' 20''$
which guddias and viguddias, because the month began at night time, are to be added to his *Saura*

(*) Vide Table XLVIII, part 2d.

place, as *calat* and *vicalat*. Hence, after applying the usual Equation of Table XXVII, part 1, for $21^{\circ} 10' 20''$, which is $20^{\circ} 27''$, the Sun's Sputa Graha at Sun rise at Lanca on the 2d Margali, will be $8^{\circ} 0' 21' 30''$; and by Table XXVIII, his true motion $51' 23''$.

E

For the Sun and Moon's distance.

2d Margali at Sun.	{	☉'s Sputa Graha (D)	-	-	8° 0' 21' 30"
rise at Lanca.	{	☾'s do. do. (C)	-	-	8 5 5 24
Soob.vi.Arca Indoo Graha	-	-	-	-	<u>0 4 43 48</u>

F

For relative motion.

☉'s Sputa Gati (D)	-	-	-	-	1° 1' 23"
☾'s do. do. (C)	-	-	-	-	12 2 0
Soob.vi.Arca Indoo Gati	-	-	-	-	<u>11 0 57</u>

G

For time due to distance.

The rule will be as before $\frac{60 \times 4^{\circ} 43' 48''}{11^{\circ} 0' 57''}$ and the time due to distance $25^{\circ} 46' 27''$, and because the Moon was more advanced than the Sun in the Zodiac, the above result shews the time elapsed at Sun rise on the 2d Margali since the conjunction had occurred; therefore, from $\cdot 60^{\circ}$

					Subtract 25 46 27"
True time of Amavasya	-	-	-	-	<u>34 13 33</u>

after Sun rising on the 1st of Margali.

H

But it appears by the Solar Kalendar, page 119, that the Sun entered the sign Dhanu ♌ on the same day, at

	-	-	-	-	38° 49' 40"
	-	-	-	-	34 13 33
End of the 30th or Amavasya Tidhi	-	-	-	-	<u>4 36 7</u>

before the Sydereal commencement of the Solar month Margali, when the Sun was therefore still in the sign Vrischika ♏ ; that is, in the Sydereal month Cartiga, although the *Civil* Margali had begun.

I

Since the *Amavasya* Tidhi of the Lunar month *Cartiga* fell on the 1st Margali Sydereal account, at *night time*, it is to be coupled with *that* Solar date; and the *Pratham* Tidhi of the

D

For the Sun's apparent place on the 2d Tye at his rising, we see by the Kalendar, page 119, that he completed his 9th Sign and entered Macara vr, at

$$\begin{array}{r} 59^{\circ} 42' 41'' \\ 60 \\ \hline 0 \quad 17 \quad 19 \end{array}$$

which shews night time; therefore the *vicular* and *parar* are to be added to his Saura place, and are 17^h 3.

At the expiration of the 1st of Tye or at Sun rising on the 2d, the Sun has therefore only gained 17^h in his 10th Sign, and the ☉'s Sputa Graha is 9° 0' 0" 17" (*), and by Table XXVIII the Sun's true motion on the 2d Tye is 61° 23' or 1° 1' 23'.

E

For the Sun and Moon's distance.

2d Tye at Sun rising ☉'s Sputa Graha (D)	-	-	9°	0'	0"	17"
at Lanca ☽'s do. do. (C)	-	-	8	25	37	39
Soob.vi.Arca Indoo Graha	-	-	-	4	22	33

F

For the relative motion.

☉'s Sputa Gati (D)	-	-	-	-	1°	1'	23"
☽'s do. do. (C)	-	-	-	-	12	6	0
Soob.vi.Arca Indoo Gati	-	-	-	-	11	4	37

G

And for the time due to distance.

$$\frac{60 \times 4^{\circ} 22' 38''}{11^{\circ} 4' 37''} = 23^{\text{h}} 42^{\text{m}} 35^{\text{s}}.$$

and as the Moon was less advanced than the Sun, the above quantity marks the time *after Sun rise* when the conjunction was to occur.

H

By the Kalendar, page 119, the Sun entered the Sign Macara vr on the 1st day of the Solar month Tye, at

$$\begin{array}{r} 59^{\text{h}} 42' 41'' \\ 60 \\ \hline \end{array}$$

that is, *before* Sun rise on the 2d

$$\begin{array}{r} 17 \quad 19 \\ \hline \end{array}$$

Now the Amavasya occurred (G)

$$\begin{array}{r} 23 \quad 42 \quad 35 \\ \hline \end{array}$$

after Sun rise.

$$\begin{array}{r} 23 \quad 59 \quad 54 \\ \hline \end{array}$$

(*) Here, as the fraction is only 11'', the Equation by Table XXVII, part 1, is insensible.

adding therefore these two quantities, we find that the conjunction occurred $23^{\circ} 59' 54''$, after the Syderal beginning of the Solar month *Tye*.

I

By the first part of this article, the conjunction near the beginning of Margali I fell $4^{\circ} 36' 25''$ before the Sun entered the Sign Dhanu I (page 139), and by the second part, the *Amavasya* which was to occur about the beginning of *Tye* v took place $23^{\circ} 59' 54''$ after he had left it (page 141). Hence there was no conjunction during the time that the Sun was in the Sign Dhanu I ; in consequence of which the name of one of the Lunar months, (which in the present case is *Margasira*) is to be passed over; and that which follows the Solar month *Cartiga*, (viz. *Paushia*), is to be used. In the *Panchangum*, however, it is customary to write the names of both; annexing the word *Cshaya* thereto. Thus we find in the *Kalendar* of A. C. 4924, page 68, for the month under consideration, *Cshaya Margasira Paushia*.

How in that year the Lunar month *Cartiga* happened to correspond with the Solar *Cartiga*, and occasioned *Paushia* to answer to *Margali*, will be explained in the next article.

I shall close these observations by a remark of Auddy Sasthaya, which I give in his own words.

“As it is customary in the first instance to compute the general *Adigah*, and *Cshaya* months, such as these would occur at *Lanca*, which is supposed to have neither Latitude, nor Longitude, the results of such computations must be considered as indispensable approximations, without which, the problems could not be resolved.

“But when afterwards computing the *Kalendar* for any particular place, where there is of course Latitude and Longitude, there may sometimes be both an *Adigah* and a *Cshaya* at *Lanca*, and none at the proposed place.

“When there is a great difference of time between the commencement of the Solar month, and the preceding conjunction, then the *Adigah* and *Cshayas* will be the same all over India; but in the contrary supposition, when that interval is but small, the case may be otherwise.”

ARTICLE 5.

Resolution of the two Amavasyas which determine the first intercalation due to the year 4924 of the Cali yug.

Resolution of the two Amavasyas which determine an Adigah month.

If the order of the times were followed, this article should have preceded that which treats of the expunged month of the same year, for in the case of a double intercalation the first *Adigah* month always precedes the *Cshaya*.

But it will be shown in the third part of this *Memoir*, that the first indication of a *Cshaya* is that a mean *Adigah* month will fall in any particular year, on a month where it cannot possibly be inserted, because the Solar month happens to be shorter than the Lunar one. The *Cshaya* is therefore the accident which draws with it the double intercalation, and prepares us for the same, and on that account it was entitled to the precedence.

As it generally occurs that when the *Cahaya* falls on *Margasirar*, the first *Adigah* day in the same year occurs in the Solar months which answer to the Lunar *Asvina* and *Phalguna*, and which are *Paratasi* and *Poonmoni*, I shall now proceed to the resolution of the two changes which affect the former.

Resolution of the first Amavasya which determines an Adigah month.

For the *Ahargana*.

	4923	Lunar.	4924	Solar.
<i>Ahargana</i> 30th Lunar <i>Phalguna</i>	1798147	☉ 1st <i>Chaitram</i>	-	1798166° 20' 12" 30"
Add 6 Lunations	-	177	Time to run to the last day of Ayan, Table XLVIII, p. 2.	156 23 43 6
	1798324	<i>Ahargana</i> 1st <i>Paratasi</i>	-	1798322 [46 56 36 + 2

Ahargana 3d *Paratasi* at Sun rise 7)1798324 (256903
remainder 3

which remainder 3 being counted from *Friday*, gives the *Sesta dina*, *Soma-vara* (Monday); and as we have added 2 days to the *Ahargana* of the 1st *Paratasi*, the computation will be for the 3d at Sun rising.

Having found that the Sun entered the Sign *Uzanya* ☿ on the 1st *Paratasi* at 46° 56' 36" after Sun rise (Kalender, p. 119), and that the *Ahargana* to be used was 1798324, I shall briefly state, that the *Chandra Vakiam* is 187; the Moon's *Arca Bhagabala* — 4° 40'; her *Drava* 6° 25' 56" 40", its Equation 10° 3' 52" 0", and the Sun's Equation — 1 40 (Table XXVII). The respective Longitudes at Sun rise on the 3d *Paratasi*, will therefore be,

3d <i>Paratasi</i> , at Sun	☉'s Spata <i>Graha</i>	-	-	5° 1' 11" 23"
rise at Lanka	☿'s do. do.	-	-	5 7 44 0
<i>Soob.vi.</i> <i>Arca Indee</i> <i>Graha</i>	-	-	-	0 6 32 37

The relative motion by Tables XXVI and XXVIII.

☉'s Spata <i>Gati</i>	-	-	-	53 26
☿'s do. do.	-	-	-	13 3 0
<i>Soob.vi.</i> <i>Arca Indee</i> <i>Gati</i>	-	-	-	12 4 34

The time due to distance is therefore $\frac{60 \times 6' 32' 31''}{12 4 34}$ - 32° 30' 42"

and as the Moon was more advanced than the Sun, it shows that the conjunction had passed, and that the time above found is to be retrenched from that of Sun rising on the 3d *Paratasi*, when the 2d is completed.

Time of conjunction on the 2d after Sun rise	-	-	60° 0' 0"
	-	-	32 30 42
	-	-	27 29 18

Resolution of the
1st *Amavasya* in
Paratasi.

	G.	V.	P.
Now the Sun entered the Sign <i>Canya</i> ☾ on the 1st <i>Paratasi</i> , at	46	56	36
	60	0	0
After Sun rise ; there remained therefore from that instant to the 2d	13	3	24
And the time of conjunction being on the 2d after Sun rise, at	27	22	18
The <i>Amavasya</i> took place	40	32	42
after the Sun's entrance into the new Sign, when $40^{\circ} 32' 42''$ had elapsed.			

Second Amavasya.

Revolution of the 2d
Amavasya which
determines an *Adi-
gah* month in *Para-
tasi*.

When two successive conjunctions are to be determined, the Hindu computers contrive to abridge the process by omitting to consider the *Ahargana*, and working for the Sun's place, by adding the absolute duration of the following Solar month to the fractional part, in guddias, vigudilias, &c. of the time of beginning of the month elapsed. This gives the *Sydetical* end of the month to be worked for: but as the Sun and Moon's apparent places are wanted for the time of Sun rising, the excess of time over a complete day (which in Solar computations is always the instant referred to) is to be retrenched from the entire Sign, if the preceding morning be wanted: but its complement to one degree is to be added if the end of the same day be required.

A particular method
for shortening the
process.

In the same manner they avoid computing again the *D's Druva*, by considering first what the *Chandra Vakiam Dhurmanham* was at the last conjunction; then adding thereto the number of complete days resulting from the addition of the duration of the absolute month to the fractional part spoken of at the beginning of this article, and subtracting the number of days that may have been added to the beginning of the month for reaching the *Lunar Soota dina*, the remainder gives the *Chandra Vakiam*, or Argument sought. And secondly, considering that the Moon's *Druva* varies only once in a *Devaram* or 248 days, they conclude that having only added 29, 30, or 31 days to the original *Ahargana*, it may not have increased during that interval, on which they proceed, being certain that the result will prove whether the assumption has been a right or a wrong one.

As the process here adverted to has not yet been presented to the reader, I shall compute the second *Amavasya* more in detail than I otherwise should have done.

A

	D.	G.	V.	P.
The fractional part of the last Solar <i>Ahargana</i> (page 143) was	46	56	36	
The absolute number of days in the Solar month <i>Paratasi</i> , Table III, is	30	27	22	1
Epoch of Sun's entrance into the Sign <i>Tula</i> ☐	31	14	18	37

which therefore began at day time, so that the guddiar and viguddiar are to be subtracted as calas and vicalas from the Sun's Saura place; but as on the 1st Arpesi the Equation given in Table XXVII, part 1st, is only 1' in 8 days, it is insensible in the present case, being only 1", and may be neglected. The Sun's Longitude at Sun rise of the 1st Arpesi, will

therefore be	-	-	-	-	-	6° 0' 0' 0"
Subtract the guddiar as calas	-	-	-	-	-	0 0 14 18
☉'s Suta Graha sought	-	-	-	-	-	<u>5 29 45 42</u>

and by Table XXVIII his true motion is 59° 44' on the 1st Arpesi.

B

The Sun's Anomalistic Equation by Table XXVII, part 2d, will be found — 3° 7' 25"; and the Lunar Arca Bhagábala — $\frac{27^{\circ} 1' 25''}{27} = 4' 43''$

C

For the Moon's Drava, Chandra Vakiam; and apparent place.

The Chandra Vakiam found for the last conjunction (page 143) was	-	-	-	-	187°
To which add the number of entire days found at article A	-	-	-	-	31
					<u>218</u>
But 2 days had been added to the Solar Ahargana for equating it to the Lunar one, which subtract	-	-	-	-	2
Chandra Vakiam for the present operation	-	-	-	-	<u>216</u>

Now as we have only added 31 days to the Ahargana for Poratari, the Vakiam of which was 187 days, we may suppose that the Moon's Drava has not changed; we take it therefore as at page 143.

☾'s Drava	-	-	-	-	-	6° 28' 56' 40"
Add Equation due to Vakiam 216	-	-	-	-	-	11 0 21 0
						<u>5 29 17 40</u>
Subtract Moon's Arca Bhagábala	-	-	-	-	-	4 43
☾'s Suta Graha, 1st Arpesi	-	-	-	-	-	<u>5 29 12 57</u>

and her true motion, Table XXVI, 76 calas, or 12' 41'.

D

For the Sun and Moon's distance.

2d Arpesi at Sun } ☉'s Suta Graha (A)	-	-	-	-	-	5° 29' 45' 42"
rise at Lanka } ☾'s do. do. (C)	-	-	-	-	-	5 29 12 57
Distance	-	-	-	-	-	<u>0 0 32 45</u>

E

Relative motion.

☉'s Sputa Gati (A)	-	-	-	-	-	0' 59' 43"
3 1/2 do. do. (C)	-	-	-	-	-	12' 41' 0"
Relative motion	.	.	.	.	.	<u>11' 41' 16"</u>

F

For time due to distance.

$$\frac{60 \times 0^{\circ} 32' 43''}{11' 41' 16''} = 2^{\circ} 48' 6'', 8 \text{ after Sun rise.}$$

G

We have found at article A, that the Sun entered the Sign Tula ♎ on the 1st Arpasi after Sun rise, at

14° 18' 37"

And by the last article F, that the conjunction took place also on the 1st, after Sun rise, at

2° 48' 7"

There wanted therefore

11° 30' 30"

11° 30' 30" of time when the Amavasya occurred, for the Sun to enter the Sign Tula ♎; he being then still in Canya ♎.

*CONCLUSION.**Conclusion.*

The first Amavasya took place on the 2d Parvati (page 144) 40° 32' 42" after the Sun had entered the Sign Canya ♎; and the second, or that of the ensuing Lunar month, when there wanted 11° 30' 30" of his entrance into the Sign Tula ♎, from which it follows that two conjunctions occurred during the time that the Sun was in Canya ♎, and therefore, the name of the Lunar month *Armasa*, which concurs with the Solar *Parvati*, must be repeated, calling it *Adigah* the first time, and *Nija* the second.

It would be a misapplication of time and labour to give the further resolution of the second intercalation, which in the 4924th year of the Cali yug, (or the 1745th from the birth of Saitrahana) occurred during the Solar month *Poongoni*, and fell on the Lunar *Phalguna*, called *Phaiguna Mitick*, or *Adigah Chaitra*; so that in the said Luni-solar year there were two *Chaitras*, and no *Margasiras*. The process for both intercalations is in every respect the same, and (as far as I am able to judge) requires no further illustration.

I shall, therefore, close here my researches into the Astronomical part of the Luni-solar Panchangum, which by some classes of readers will, I have no doubt, be deemed unnecessarily extended. I declare, however, that I long, but vainly endeavoured to reduce these two parts of the second Memoir to a narrower compass. Whatever I attempted to retrench, left a chasm which I was compelled to fill again, because it interrupted the course of argument, prevented the exposition of certain ingenious methods intended to shorten the process, and in some cases deprived the reader of the opportunity of useful references.

NOTE.

I have already stated that it is an invariable practice throughout India, to call each Solar and Luni-solar year by the name of that of the Cycle of 60 years to which it corresponds; a custom which may prove of great resource in Chronological researches. As there will be found in this collection a separate Tract which treats especially of the three different modes according to which the years of the *Vrihaspati Chakra* are computed in different parts of India, I shall only advert here to two very short practical Rules which elicit the name due to any proposed year, either according to the precepts of the *Surriah Siddhanta*, or to the *Tellinga* account, both of which are given in the General Tables at the end of the Volume.

Note on the specific name given to each Hindu year, whether Solar or Luni-solar.

I.

According to the *Surriah Siddhanta*.

“ Divide the numeral of the proposed year by 80; add the quotient to the dividend; divide the sum by 60, and the quotient will give the number of cycles expired since the beginning of the Cali yug; and to the remainder, if the proposed year be less than 31 from the last expunged year of the *Chakra* (to be found in Table XVIII), add 23; but if the said year falls in the 55 remaining years of a cycle of 86 years, add 27; and the remainder so increased will indicate the numeral of the year current of the *Chakra*, and consequently its appropriate name.”
(For an Example, see page 214).

Precept for the name of the *Chakra* year according to the *Surriah Siddhanta* and *Tika*.

II.

The same according to the *Tellinga* account.

“ Divide the years expired of the Cali yug by 60; the quotient will give the number of cycles expired, and the number of units in the remainder counted from *Pramathi*, the 13th of the *Chakra*, as one, will give the name of the last *Vrihaspati* year expired, and the following one that of the year sought.

Precept for the name of the *Chakra* year according to the *Tellinga* account.

EXAMPLE.

Let the name of the same year of the Cali yug 4924, be wanted according to the *Tellinga* account.

Example,

$$\begin{array}{r} 60)4923(82 \\ \underline{120} \\ \text{remainder} \quad 3 \end{array}$$

which counted from *Pramathi* as one, gives *Briya* for the name of the last expired, and *Chitra bhana*, the 16th of the *Chakra*, for that of the current one.

Although I have taken notice of some of the *Astrological* articles and ephemerides in the description which I have given of the *Siddhanta Chandra Panchangum* at the beginning of this Memoir, yet I shall not attempt to analyze any of them before dismissing it. But if the reader

be curious in these matters, he may collect valuable information on the *Yoga, Carna* and *Isharam*, on referring to the commentary which follows the present tract.

N. B.—I was told by the Madras Sastras that the Luni-solar year, which is chiefly used in Bengal, is the *Bhava Husputta Chandra Mana*, the months of which, considered as secondary, are called *Gana*, in contradistinction to *Mukya*, the name given to those of the *Siddhanta Chandra Mana*, which are primary, the former beginning with the *full Moon* instead of the new Moon which precedes the commencement of the Solar year. As I have sometimes found the Carnatic Pandits and Sastras misinformed on matters of Bengal usages, and customs, and particularly on those which depend on Hindu Astronomy, they may also be mistaken in this statement; but it is a point which may be easily settled in Calcutta. Be this as it may, however, as I find it stated in several books that the *Bhava Husputta*, differs in no respect, but in the time of its beginning, from the *Siddhanta Mana* (as it is called on this Coast), the same principles and rules which were disclosed in this Memoir, will serve equally for the construction of the above mentioned Luni-solar year.



PART III.

On the Hindu method of determining the mean Epochs of Intercalation.

ALTHOUGH Hindu Astronomers seem never to have been much in the habit of foretelling celestial Phenomena for remote times, yet (as we have already seen) they are in no respect deficient in means for calculating with a certain degree of accuracy, the occurrences which depend on time for any Epoch whatever.

The manner of intercalating the Lunar months being an article of the first importance in the construction of the Panchangum, the rare and unequal recurrence of double intercalations with a consequent expunged month, made them consider how these circumstances might be anticipated with a tolerable degree of certainty and without that expenditure of time and labour, which loose trials by the Siddhanta rule, must necessarily occasion. This attempt naturally suggested the resolution of the mean Epochs when from the combined revolutions of the Sun and Moon these Equations were done. They seem first to have attended to the relative motion of the two Luminaries, and then proceeding more scientifically to those of their Apogee, they concluded that when the Moon in Apogee coincided with the Sun in Perigee, it necessarily occasioned a simultaneous short Solar, and long Lunar month; lastly, they discovered that when the Moon's Apogee was in about fifteen degrees of either of the Signs *Prishica* ♈, *Dhanu* ♐ or *Macara* ♑, (which for many ages past are in possession of the Sun's Perigee), if a mean intercalation was due about the middle of the corresponding Solar month, it was impossible that the Epoch elicited by their rules for intercalating should be the true one consistently with their own theories.

For since each of the three Solar months *Cartiga*, *Margali* and *Ty* are now shorter than a mean Lunation; and since the Moon when near her Apogee has a slower apparent than mean motion, it is manifest that under such circumstances neither of the three aforesaid short Solar months could contain two changes of the Moon.

The same consideration must have also led them to discover that when there was no change in either of the said short Solar months, then there were two new Moons in two other months of the same year (or to be more precise, a double change in one of the six preceding, and another in one of the six following months), occasioning thereby two intercalations where only one could be admitted. They appear then to have taken a hint from nature, and agreed to suppress the month on which no conjunction occurred: thus preserving, with apparent metaphysical consi-

tency, both the general theorem, and that Equation of one Lunar month only which was sufficient for keeping the commencement of the Luni-solar year, within its accustomed distance, from that of the Solar one.

If we consider well the nature of their Chronological doctrines, we must admit that, under the force of circumstances, they could not adopt a less arbitrary measure; for it depends more upon nature (though much less to the purpose) than our bisextile intercalations, and is less exceptionable than the irregular, and indefensible duration of our months.

Such, after an attentive consideration of the doctrine of Lunar intercalations, appears to me the origin of the theory and practice of a method which has no doubt led to the discovery of the three Cycles of 19, 141, and 160 years, in either of which a double intercalation must recur.

ARTICLE 1.

The resolution of mean intercalations by the Hindu rule.

Mean intercalations. Let it be proposed to determine whether an intercalation be due to the 4924th year of the Cali yug current.

Rule. 1^o Reduce the proposed years into mean or Saura months.

$$4923 \times 12 = 59076 \text{ Saura months.}$$

Then say, as the number of Saura months in a Maha yug	-	-	51840000
To the number of Adigah months in the same	-	-	1593336
So the number of Saura months above found	-	-	59076

To the number of Adigah months sought	-	-	1815
			$\frac{1593336 \times 59076}{51840000}$

with a remainder of 35317506.

Now from the divisor	-	-	51840000
Subtract the remainder	-	-	35317506
Second remainder	-	-	13322494

which second remainder divide by the number of Adigah months in a Maha yug.

$$13322494 \div 13522404 (8 \text{ months})$$

$$\text{Remainder } 775906$$

$$\text{Multiply by } \times 30$$

$$23274180 (14 \text{ days})$$

$$\text{Remainder } 967476$$

$$\text{Multiply by } \times 60$$

$$58048560 (36 \text{ guddias})$$

$$\text{Remainder } 788464$$

$$\text{Multiply by } \times 60$$

$$47307840 (29 \text{ vigaddias})$$

$$\text{Remainder } 1100096$$

$$\text{Multiply by } \times 60$$

$$66005760 (41 \text{ paras})$$

Remainder which need be carried no farther 678984

EXAMPLE II.

For the year 4782.

For the year 4782
by the Tables.

Here, in order to save trouble we may start from the nearest year already expounded.

Which being 4744 (Example I) we take any Epoch already	Y	M.	D.	O.	V.	
expounded, which call <i>Drusa</i>	4744	9	4	14	10	(Example I).
Part II,	37	11	14	51	50	
	<hr/>					
	4782	8	19	9	0	
Cshapa, or Equation				+ 3	50	
	<hr/>					
	4782	8	19	12	50	

which quantity is the same as that produced by the Hindu rule.

EXAMPLE III.

For the year 5064.

For the year 5064
by the Tables.

We may commence with the Epoch of 4923, elicited in Example I.

<i>Drusa</i>	Y	M.	D.	O.	V.	
Part II,	4923	8	14	36	30	(Example I).
	132	10	7	11	55	
	<hr/>					
Part I,	5055	6	21	48	25	
	8	1	13	11	45	
	<hr/>					
	5064	8	10	0	10	

Here we need not add the Equation, because it is already involved in the quantity which marks the Epoch of intercalation for the year 4923 (vide Example I).

In the three preceding cases we are to notice the same circumstance, namely, that each indicates the intercalation to be due on the 9th month (or 8th complete) of the respective years, which falling on the Solar month Margali (one of the 3 short ones and when the Sun is in the Sign Dhanus ♎), indicates that the order of true intercalations is interrupted (page 149); and as in the three cases, the days on which the mean one is due, are not remote from the middle of the month, if the Moon's Apogee should lie about that time somewhere near 15° of the Signs *Prishika* or *Dhanus* (♋ and ♎), the Hindus conclude that there must be two intercalations with an expunged month, in the years Cali yugam 4782, 4923 and 5064.

We shall shew presently how that Element may be expounded without having recourse to the endless Rule of the Sarriah Siddhanta.

The preceding Rule and Tables, may serve equally to determine what year is a common one; for if by adding any number of the periods given in the Table we do not elicit the proposed one, then it is certain that it is neither an Adigah nor a Cshaya year.

EXAMPLE IV.

Let it be required to know whether the year Cali yugam 4751 be an Adigah year?

Years when a month
may be expunged.Years which are not
intercalary, how
found.

Then proceeding as before.

Example II and Table XXIX,	-	-	-	47-11	9	4	14	0
Part 3,	-	-	-	18	11	22	27	25
Do.	-	-	-	16	3	6	23	30
Do.	-	-	-	2	8	16	3	55
Equation	-	-	-	4781	8	19	9	10
						+	3	50
Epoch, giving 1 year too much	-	-	-	4782	8	19	13	0

and as in the present case we could not take a lesser period out of Table IX than $27\ 8^{\circ} 163\ 35'$ (the next above zero), it is clear that the proposed year 4781 is a common *Sampat-sawan*, or year of 12 Lunar months.

ARTICLE 2.

I shall now proceed to shew how the place of the Moon's Apogee for any Epoch not ascending beyond the year Cali yugam 4309 complete (A. D. 1927) may be ascertained by means of Table XXI, as accurately as if it had been computed by the Siddhanta process.

This method, which is supposed to have been devised by Varāhā Cochinnā, an Astronomer said to have lived at the above Epoch, presupposes the knowledge of a Rule contrived for eliciting a sum of days in lieu of the Ahargana, which serves as an Index to all the Tables of the author referred to.

This Rule differs little from the common one in point of form, for like all these that we have hitherto seen, it is performed with the universal instrument the *Trikantika*; only that in order that the results may always be the same as if they had been computed from the origin of the Cali yugam, we are to add 85211 before division by 180,000, and subtract 3575864 before division by 13398334.

RULE.

To find the sum of days which will serve as an Index to the Table, for the year Cali yugam 4923.

As 4923-years of the Cali yug ended on the 12th of the Solar month Poongoni at midnight at Lanka, say.

Epoch	-	-	-	4923
				4309
Number of years elapsed	-	-	-	584

For the Index and initial feria $\frac{68340 \times 584 + 85211}{180,000} = 193$ Adigah months.

$$\begin{array}{r} 584 \\ 12 \\ \hline 6188 \\ + 193 \\ \hline \end{array}$$

Number of Lunar months elapsed 6191

To find the mean place of the Moon's Apogee by the Tables.

Rule of Varāhā Cochinnā for finding the Ahargana from the year 4309 complete of the Cali yug, as an Epoch called the Index in his process.

Precept.

Rule.

$$\frac{627043 \times 6181 - 3875884}{1143832} = 3011 \text{ Cahaya Tithi.}$$

$$\begin{array}{r} 6481 \\ 30 \end{array}$$

$$\begin{array}{r} 194430 \\ 3011 \end{array}$$

$$191389 (*)$$

Index.

Sum of days or Index

$$7)191389(27341$$

Remainder 2

which, as in the case of the Tellinga rule, is to be counted from *Tharaday*, and therefore we have, as before, *Santi-rata* (Saturday) the initial feria of the Luni-solar year 4923.

The *Drava* or mean place of the Moon's Apogee, for the last day of the 4399th year of the

Cali yug was	-	-	-	-	4° 15' 26' 17"
The <i>Bijah</i> , or correction due to the same	-	-	-	-	1 29 1 (1)
The motion of the <i>B</i> 's Apogee in 1 day	-	-	-	-	6 40 52"

For the mean place of the Moon's Apogee by the Tables on the beginning of the year.

With these data proceed as follows; the Index being 191389 days.

For the Moon's *Mandocha*.

100000	-	-	-	-	11° 8' 17' 27" 44"
90000	-	-	-	-	10 4 27 42 57
1000	-	-	-	-	3 31 22 58 29
300	-	-	-	-	1 2 24 53 33
89	-	-	-	-	8 54 38 17
9	-	-	-	-	1 0 8 48
191389	-	-	-	-	2 17 27 49 48
<i>Drava</i>	-	-	-	-	4 15 26 17 0

And as the <i>Role</i> and <i>Drava</i> are adapted for the preceding noon	-	7	2	54	6	48
Add semi-diurnal motion of the Apogee	-	-	-	+	8	20 29

The same by the <i>Siddhanta</i> process, (p. 84)	-	-	-	-	7	2 57 27 17
	-	-	-	-	7	2 57 26 12

Difference 1° 5"

Correction of *Bijah* for 4 Revolutions in a *Maha* yug.

100000	-	-	-	-	-	4° 55' 52"
90000	-	-	-	-	-	4 26 17
1000	-	-	-	-	-	2 58
300	-	-	-	-	-	53
89	-	-	-	-	-	14
9	-	-	-	-	-	2
191389	-	-	-	-	-	9 30 16

Equation due to <i>Drava</i>	-	-	-	-	-	1° 39 0 54
------------------------------	---	---	---	---	---	------------

Mean place of the Moon's Apogee	-	-	-	-	-	1 38 27 10
	-	-	-	-	-	7° 2 57 27 17

Corrected place	-	-	-	-	-	7 4 35 54 27
The same by the <i>Siddhanta</i> process (p. 86)	-	-	-	-	-	7 4 35 53 22

For the <i>Prathama Tithi</i> of the year 4923.	-	-	-	-	-	Difference 1° 5"
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(*) This process is the same as that which is used for finding the Index to the Table of the *Pancha* for computing their mean places.

(1) Table XXI.

But we want the place of the Moon's Apogee for 8^m 14^d 36^h 30^m later + the remainder in the month of Poongoni 4924 from the time of the Luni-solar date of the beginning of the Chandra year.

Now by Table III the absolute month of Poongoni contains . . . 30° 20' 21" 2"
From which subtract . . . 12

For 8 Solar months complete . . . 275° 30' 30" 11"
+ 14 36 30 0

Number of days elapsed . . . 308 36 21 13

And for the motion of the Moon's Apogee due to the same.

Table XXI . . . 300 days . . . 1° 3' 24' 23" 33"
8 . . . 33 27 50
30 guldies . . . 3 20 29
6 . . . 40 48
Bijah for 300 days . . . 53

Place of the J's Apogee, 1st Chaitram 4924 . . . 7° 4' 35" 54" 27"

Corrected place of the Moon's Apogee . . . 8° 8' 58" 18" 0"

Mean place of the Moon's Apogee on the proposed day.

at the time when the intercalation was due.

Thus we have expounded that important Element by a comparatively short process, and with as much accuracy as if we had used the Sastra Rule.

Now observing that an intercalation was due on the 15th day of the 9th month of the year 4923 (8^m 14^d complete) and that at the same instant the Moon's Apogee was in 5° 58' 18" of the Sign Dhanus ♏, corresponding with the Solar month *Margali* (one of the three short ones of the Solar year), whereas the Sun's Perigee was in 17° 17' 18" of the same Sign Dhanus (♏), there can be no doubt, from their near coincidence, that no two conjunctions can occur in the said month *Margali*; and that the Luni-solar month corresponding thereto is a *Caluya*, or expunged month, and not an *Adigah*.

Conclusion for an expunged month in the year 4924 of the Cali yug current.

The same circumstance may be argued, and the same results obtained for the years 4782 and 5064 complete, a notation which it is always necessary to keep in view when considering Hindu expressions; because the intercalation truly falls in the years Cali yugam 4783, and 5065 current. But as the Indians invariably make their computations for the end of the years, as well as of the Tidhis, those which their notation presents, imply always the year or Tidhi which has *last expired*; the fractional part of the quantities belonging to the ensuing ones.

The same for 4783 and 5065 current.

But if we come to convert the years so expressed into European time, then as the new Hindu year generally commences (as it has done for many centuries past) during the first months of the European concurring years, the intercalations and omissions, mostly fall in the course of the *same* Christian year.

In reading the columns of the second General Table, if we seek the character of the Hindu year

(*) The Sign Dhanus being the 9th current, the Perigee is in 8s 17° 17' 17" 54" because the Sun's Apogee was at that time in 2s 17° 17' 18" 54" (vide page 23).

Notation of the Adilgah and Cahaya years in the 11d General Table.

which falls opposite to A. D. 1822, and which happens to be A. Cali yugam 4923, we are therefore to understand that the latter ended in 1822, and being marked AC in the fifth column, that the intercalation and omission fall in 4924 current; but that notwithstanding the change in the notation of the Hindu year, these Equations are still introduced during the course of A. D. 1822. It must be acknowledged that this method of noting a year by its end, instead of its commencement, is somewhat inconvenient, and liable to occasion mistakes; but it could not be altered without departing from the manner of computing of the Indians, which in matters that concern them and their Tables we are bound to preserve.

Such is the preparatory method used by Hindu Almanac makers for approximating the recurrence of the Adilgah and Cahaya months, before entering into the actual computation of the same. It might have been curious to ascertain what is the greatest distance of the Solar Perigee from the Lunar Apogee necessary to cause an expunged Lunation; but I am not aware that this research would lead to any useful purpose. That circumstance occurs very rarely, and as the Indians in their approximations (besides their calculating the place of the Moon's Apogee) resort also to the probable evidence of the Cycles of 19, 144 and 160 years, I shall leave the resolution of that problem to those who may be curious in abstract speculations, the limits of certainty being sufficiently narrowed by the foregoing two rules for all practical purposes.

I shall close this Memoir by giving a last and complete resolution of the Cahaya year and month which are to occur at the period nearest to our times, by all the short rules which have been disclosed in the course of it. For this purpose we must begin by constructing the Skeleton of the Solar Kalendar for the year 5065 current (*) (A. D. 1963), as was done for A. Cali yugam 4923 current, which fell 141 years before; but as some of the articles are constant, all that we require now, is a Table of the Initial Roots of, and duration, of its months, which are variable. Dominical Letter A. D. 1963, F. Dominical Letter A. D. 1964, E D.

Skeleton of the Solar Kalendar for the year 5065 of the Cali yug current.

European dates of beginning of Solar months	Names of Solar months.	Initial Roots of months.	Sidereal duration of months	Civil duration of months.	Names and order of Zodiacal Signs.	Types of Signs.	Signs current.	Signs complete.
14 March	Poongoni 5064	(4) 28 17 43			Mia	☾	12	11
13 April	Chaitram 5065	(6) 48 38 45	30	31	Mesha	♈	1	0
14 May	Vyasaht	(2) 44 10 46	31	31	Vrischa	♉	2	1
15 June	Auni	(6) 8 22 47	31	31	Mithuna	♊	3	2
16 July	Audi	(2) 45 0 38	31	32	Carata	♋	4	3
17 August	Auvani	(6) 13 12 50	32	31	Tinha	♌	5	4
17 Septem.	Parasati	(2) 15 22 51	31	31	Canya	♍	6	5
17 October	Arpedi	(4) 32 41 52	30	31	Tala	♎	7	6
16 Novem.	Cartiga	(6) 36 51 53	30	30	Vrischika	♏	8	7
16 Decem.	Margasi	(1) 7 15 55	30	29	Dhanu	♐	9	8
15 January	Tye (A.D. 1964)	(3) 28 8 56	29	29	Macara	♑	10	9
13 February	Maussi	(3) 58 24 57	29	30	Cumb'ha	♒	11	10
13 March	Poongoni	(8) 45 48 58	30	30	Min	♓	12	11
13 April	Chaitram 5065	(1) 4 10 0	31	30	Mesha	♈	1	0

(*) Vide Part III, Article I., Introduction.

ARTICLE THE LAST.

Resolution of the double intercalation with an expunged month which is to occur at the nearest period to present times, reduced to the Geographical position of Madras.

By the Vakiam Tables and Solar process.

Although the present article contains no new doctrine, but merely applies to a particular case—those which have already been disclosed, yet after due consideration of the expediency of retrenching it from the body of this work on that score, I have suffered it to remain as a document which predicts a remote contingency; the only one of its kind that can possibly occur before 140 years have revolved. What follows may therefore interest the philosophers of the twentieth century, if these imperfect but elaborate pages live to that extent of time.

The Rule for determining the Epochs of mean intercalations given at page 132, has warned us that a mean intercalary Lunar month will be due in the ninth month of the 5065th Solar year of the Cali yug (1836 Sacs); and as on the beginning of that year the Sun's Apogee will lie in $2^{\circ} 17' 17'' 34''$ of the Hindu Sydercal Zodiac; and as the Ayanansa on the 1st Chaitram of the same year (13th April 1903) will be $21^{\circ} 51' 19''$, the said 9th month, (that of Margali) will still be one of the three short months of the Solar year. The Lunar intercalation which is due at that time, cannot therefore be introduced in that specific month, particularly if the Moon's Apogee happens then to lie near the middle of any of the three Zodiacal Signs *Vischikha* III, *Phanua* I, or *Matara* VI.

Having computed that Element by means of Varilala Cochinn's Index and Tables, as shown at page 153, and found it to lie, on the 10th Margali 5065, in $7^{\circ} 11' 36'' 9'' 12''$; and the precise time of mean intercalation above referred to, being 5064y 8m 10d 0h 10m; knowing also that the Sun will complete its 8th Sign on the 1st Margali, we may conclude from these joint considerations, that the Lunar month which will happen to coincide with that of *Margali* instead of an *Adigha*, will on the contrary be a *Ghaya* month.

On this supposition if we proceed according to the Vakiam process, we shall find the following Elements.

SECTION I.

The Solar Abargana on the 1st Margali 5065, by the Ariah Siddhanta (Table XLVIII, part 2) is 1849014 $^{\circ}$ 7' 15" 35", and the Lunar, at the expiration of the 9th Lunation of the corresponding Luni-solar year, by the Surriah Siddhanta (Table XLIX, part 1) 1840914. The *Soota dina* epochical feria of the Solar month Margali is *Soma-vara*, or *Monday* (Kalendar, page 156).

The Rule for intercalating announces an *Adigha* in the 9th month of the 5065th year of the Cali yug.

The 9th month of the said year still one of the 3 shortest months.

The Moon's Apogee in $7^{\circ} 11' 36'' 9'' 12''$ on the 10th Margali.

Elements of 1st conjunction at the end of Caitika.

1st Margali 2005 at Sun rise at Lanca.	☉'s apparent place	-	-	-	7° 29' 32" 33"
	His true motion	-	-	-	1 1 23
	☿'s apparent place (her Chandra Vakiam being 2; Drava 7° 4' 28" 3"; Equation 0° 24' 0" 0"; and Arca Bhagabala — 1' 27")	-	-	-	7 29 35 36
	Her true motion	-	-	-	12 6 0
	☉ and ☿'s distance	-	-	-	1 17 18
	Relative motion	-	-	-	11 4 57
	And the time due to distance	-	-	-	6' 55" 17"

And as the Sun at his rising at Lanca will be more advanced than the Moon, the last result indicates the time that will be wanting of the instant of conjunction at that moment, and shows that the *Amavasya* will occur after Sun rising.

But the Sun (Kalendar, page 156) will enter the Sign Dhanu I on	a.	v.	p.
the 1st Margali, after its rising, at	-	-	7 15 55
From which subtract time of <i>Amavasya</i>	-	-	6 58 17
Time before the commencement of the Sydercal Solar month	-	-	0 17 38

Time of conjunction
before the com-
mencement of the
Sydercal month
Margali.

So that the *Amavasya* will take place at Lanca, not in the Solar Sydercal month *Margali*, but on the last Sydercal day of *Cartiga*.

SECTION II.

Second *Amavasya*.

After having added to the foregoing Solar Ahargana, the absolute duration of the Solar month *Margali*, as given in Table III, the Solar Ahargana will be 1846043' 28' 2' 50"; but as in the present position of the Sun and Moon's Apogees the Lunar Synodical, is longer than the Solar month *Margali*, we are to add one day more thereto, and the Ahargana to be used will be 1846044 corresponding to the 2d Tyē 5005, which, proceeding as usual, will be found to fall on a *Wednesday* or *Bhadra-vara*. But it will be more expeditious to dispense with the Ahargana, and use the short process indicated at page 147. By either way, however, the Elements for the 2d *Amavasya* will be found to be as follows :

Elements of 2d con-
junction in the
beginning of Tyē.

On the 2d Tyē 5005 at Sun rising at Lanca.	☉'s apparent place	-	-	-	9° 0' 32" 33"
	His true motion	-	-	-	1 1 23
	☿'s apparent place (the Chandra Vakiam being 32; her Drava, the same as for the preceding month, 7° 4' 28" 3"; Equation 1° 27' 30" 0"; and Arca Bhagabala — 1' 7")	-	-	-	9 1 56 55
	Her true motion	-	-	-	12 28 0
	☉ and ☿'s distance	-	-	-	1 24 21
	Relative motion	-	-	-	11 26 37
	And the time due to distance	-	-	-	7' 22" 10"

As the Moon is more advanced than the Sun, the last quantity shows the time that will be elapsed at Sun rise since the conjunction has taken place.

OPERATION.

The ☉'s true motion on the 1st Margali being $61^{\circ} 23'$, and the Longitude of Madras at time being $47^{\circ} 4'$ East, the Equation due to that interval of time is $- 48'$, and consequently the Sun's apparent place at time of mean Sun rising at Madras is $7^{\circ} 29' 52'' 6'$.

The ♃'s true motion on the same day being $12^{\circ} 6'$, and the Longitude as before, the Equation due to the same is $- 9' 29'$, and the Moon's apparent place on the 1st Margali at time of mean Sun rising is $7^{\circ} 28' 26'' 7'$. The ☉ and ♃'s true distance is $1^{\circ} 25' 59''$; the relative motion $11^{\circ} 4' 37''$, and the time due to distance $7^{\circ} 45' 44''$, which, because the Moon was less advanced than the Sun, marks the time wanting of the conjunction at mean Sun rising at Madras.

SECTION IV.

We are now to compute the time of true Sun rising at the proposed place on the said 1st Margali, so as to express the time of conjunction with reference to that instant; and for the resolution of that problem, we have recourse to what has been said in the second part of this Memoir on Hindu Gnomonics.

Although we have already given an example of the application of these doctrines when computing the end of the 30th or last Amavasya Tithi of the year 4925 of the Cali yug, yet as other matters have intervened, one example more, of a rather intricate proposition, may not be superfluous for those who may be desirous of making further progress in Hindu Astronomy.

A.

For the Ravi Sayana, or Sun's Longitude on the Tropical Sphere.

☉'s Suta Graha, 1st Margali	-	-	7	29	52	6
Ayanansa on the same day	-	-	+	21	58	3
Ravi Sayana, 1st Margali, at Madras	-	-	8	21	50	9

B.

For the *Ullagna* of Madras, or Arc of the Equator which rises above the Horizon with the Sun, being what the Hindus call the *Suta* or true quantity which determines the Sun's diurnal motion in oblique ascension.

By article 5^e, Section II, Problems A and B of Gnomonics, page 104, we have

As 30° (1800 calas) to 1980 calas, (the *Ullagna* of Madras for 9 Signs, Table XLVI), So $61^{\circ} 23'$ (the Sun's true motion in Longitude), To $\frac{1980 \times 61^{\circ} 23'}{1800} = 67^{\circ} 30'$ the Sun's diurnal motion in oblique ascension, required.

C.

For the length of the Socon or natural day.

We have already observed that as there are 216000 pranacalas (6 in a vicala) in a natural day,

The Sun and Moon's places referred to the Tropical Sphere.

Diurnal motion of the Sun in oblique ascension.

and the same number of calas (minutes of a degree) in the Equatorial Circle, or $350'$; there 67 calas, 30 vicalas, represent *pranacalas* in time; therefore if we divide by 6, or $\frac{67 \cdot 30}{6}$, we have $1st \frac{1}{2} = 11 vic. 1 pra.$; and $2d$, $60 : 30' :: 10$ (castacalas) : 5. Hence the Equation sought is 11 vic. 1,5 pra. to be added to the mean Sydercal day.

The length of the Saran day required is therefore 60 dan. 11 vic. 1,5 pran. expressed in Murta time. Length of the natural day in Murta time.

For the length of the artificial day or time of the Sun being above the Horizon on the 1st Margali 5065 current.

A'

The length of the natural or Bhumi Saran day being 60 dan. 11 pal. 1,5 pran., its fourth part, is 15 dan. 2 pal. 4,9 pran. (*) or $15^h 2^m 49^s$, being one half the mean artificial day and night. The same in Solar time.

To have the true duration of each we are to find the Sun's Declination, or *Cranti Bagahr*, and Ascensional difference, or *Chara Cumda*.

B'

For the Sun's Declination (Gnomonics, Sect. II, para. 60 B, page 105).

The Ravi.Sayana (A, preceding page)	-	8° 21' 50" 9"
The Sine of which is	-	3402'
The Obliquity of the Ecliptic (constant)	-	24°
And its Sine or <i>Paramupa.Cranajya</i>	-	1397'

Then say

: Radius 3433 : Sine Sun's Longitude 3402' :: Sine Obliquity 1397' : $\frac{3402 \times 1397}{3433} = 1382'$ the Sine of the *Cranti Bagahr*, or Declination sought, corresponding to an Arc of $23^\circ 43'$ South. The Sun's Declination.

C'

For the *Chara Cumda*, or Ascensional difference (Gnomonics, Sect. II, 60 C, page 105).

DATA.

	Sine.	Cosine.
The Altitude of the Pole is $13^\circ 4'$ its	777'	3348'
The Sun's Declination $23^\circ 43'$ South	1382'	3148'.

Say 1^o (Cos. $13^\circ 4'$) 3348' : (Sine Do.) 777' :: (Sine $23^\circ 43'$) 1381' : $\frac{1381 \times 777}{3348} = 320'$,

the *Cshetijya*, being the first approximation.

2^o (Cosine $23^\circ 42'$) 3148' : (Cshetijya) 320' :: (Radius) 3433 : $\frac{320 \times 3148}{3433} = 349'$, the Ascensional difference.

Chara, or Ascensional difference sought, which converted into time by Table XXXI, answer to $58^m 10^s$.

(*) Because in a vicala or pala there are 6 pranacalas, and that in a vigaddia there are 60 panas.

For the *Dinarda* and *Ratri-Arda*, or half the artificial day and night on the 1st Margali at Madras. (Gnomonics, Sect. II, 6^o D, page 106).

A'

Because the Sun's Declination is South, from the fourth part of the natural day (A', preceding page)	a.	r.	p.
	15	2	49
Subtract Chara in time (C', preceding page)		38	10
<i>Dinarda</i> , or half artificial day	14	4	39
And for the night	15	2	49
Add Chara	+	38	10
<i>Ratri-Arda</i> , or half artificial night	16	0	49

B'

Artificial day and night.

The <i>Dina</i> , or entire day, is therefore $2 \times 14^{\circ} 4' 39''$	28	9	18
And the <i>Ratri</i> or entire night $2 \times 16^{\circ} 0' 49''$	32	1	38

C'

For the true time of Sun rising.

True time of Sun rising at Madras.

The time of noon is always expressed by	75	0	0
Subtract <i>Dinarda</i>	14	4	39
60 gni. + Equation of time, that of Sun rising at Madras on the 1st Margali	60	55	21
Add the whole <i>Dina</i> or artificial day	28	9	18
True time of Sun setting on do.	29	4	39

D'

It was found, page 169, that the conjunction will occur at Madras after mean Sun rise at

But the Sun rises truly on the 1st Margali at Madras after 60 guddias (C', present page)

Difference 6 50 23

Conjunction after true time of Sun rising, 1st Margali.

which shows that the Amarasya will fall at $6^{\circ} 50' 23''$ after true Sun rising at Madras, on the 1st Margali 5065.

E'

When the Sun entered the Sign *Dhanu* 1, at Lanca (Kalendar, page 156), at

Add *Desantara* in time

It was mean time at Madras
Subtract Equation of time (C')

Time of conjunction before Sydercal beginning of Margali.

Time of ☉'s entrance in 1 after true Sun rising
Time of conjunction above found

Time before Sydercal commencement of Margali 1
That which was found at page 158 (being computed for Lanca) was

Difference - - - 23

Second Anuvarga.

The process being absolutely the same, I shall only give the results.

☉'s Sputa Graha mean time of rising at Madras after accounting				
for the difference in Longitude of 47° 4' E. 2d Tye 5065	9	0	31	47
☿'s do. do.	9	1	47	10
☉ and ☿'s distance		1	15	23
Relative motion		11	26	37
	G. V. P.			
Time of conjunction before Sun rising of 2d Tye		5	35	14
Or after mean Sun rise on the 1st do.		53	24	45
☉'s motion in Oblique ascension		1	4	23
	dan. viralat. pes.			
		10	4	4
The same reduced into <i>Muria</i> time				
Duration of natural day at Madras in do.	60	10	4	4
Therefore $\frac{1}{4}$ the natural day;				
	d. e. pra.			
	60 10 4,4			
or $\frac{1}{4}$ the artificial	15	2	4,1	or 15 2 41
	dan. vic. pra.			
The ☉'s Declination		22	5	
The <i>Caketiya</i>				299
The <i>Charajya</i>				322
And the <i>Charu Gunda</i> in degrees		5	20	
	V. P.			
		53	20	
The same in time by Table XXXI,				
	G. V. P.			
Hence the artificial day		28	18	42
the artificial night		32	12	2
<i>Dinarda</i> or half artificial day		14	9	21
<i>Ratri-arda</i> or half artificial night		16	6	1

From these results we come to the following conclusions.

	G.	V.	P.
The expression for noon time being always	75	0	0
And the <i>Dinarda</i> being	14	9	21
We have 60 guldias + the Equation of time for Sun rising	60	50	39
Add the whole <i>Dina</i> or duration of artificial day	28	18	42
Time of Sun setting after Sun rise on the 2d Tye	29	9	21

For time of conjunction after true Sun rising at Madras, on the 1st Tye 5065.

Time of conjunction after mean time of Sun rising on the 1st Tye	G.	V.	P.
5065 (present page) at Madras	53	24	45
Equation of time, present page, subtract		50	39
Time of true conjunction after true Sun rise on the 1st Tye A. Cal.	53	34	7
5065 at Madras			

Results of reductions of the 2d conjunction in the Solar month Tye.

CONCLUSION.

Conclusion.

By the Kalendar, page 155, the Sun will enter the Sign <i>Macara</i> π .	π .	π .
on the 1st Civil day of Tye, at <i>Lanca</i> , after Sun rise, at	28	8 50
Add Longitude in time	+	47 4

The same at <i>Madras</i> after mean Sun rising	-	-	28	50	0
Subtract Equation, preceding page	-	-	-	50	30

Which remainder subtracting from time of conjunction above found	28	5	21
	52	34	7

Leaves the time of conjunction at <i>Madras</i>	-	-	24	25	46
---	---	---	----	----	----

after the Sun will have left the Sign *Dhanus* ζ and entered *Macara* ν .

The year 3065 of the Cali yug is *Calaya* at *Madras* as well as at *Lanca*.

It appears therefore, that the 3065th year of the Cali yug will have two intercalary, and one expunged, months at *Madras*, as well as at *Lanca*, because the first conjunction under consideration will occur at that place $17^{\circ} 13'$ before the Sun enters the Sign *Dhanus* ζ , and the second $24^{\circ} 25' 46''$ after he has left it, which was to be determined.

OBSERVATION.

Delalande complains somewhere, that although the science of Astronomy has appeared to the greatest men of all ages a study worthy to be followed through life, yet he was often compelled to answer the following question "Of what use is Astronomy?"

In the same manner, after having waded through a mass of theories and computations, the seeming object of which was merely to determine two circumstances to which the Hindu Lunar-solar account of time is subject, I expect that many a reader will ask "Of what utility is so long and fatiguing a research?" especially since it has been observed that (with the only exception of the country called *Tellingana*) the custom of dating documents by the *Tidhis*, has long since been abrogated in all parts of India; and that even there, a Lunar-solar *Tidhi* is never proposed as a date, without annexing thereto the concurring Solar *Thady*.

To which I shall answer, as the French Philosopher did, that to do away an error widely diffused, and to remove ignorance from any post which has influence over the concerns of men, must be practically useful in all times and countries. When several years ago I was called upon to look into the *Tellinga* Kalendar, so little was its construction understood, that the best informed Gentlemen with whom I conversed, even some who from inclination and habits were best acquainted with Hindu learning and usages, entertained a belief that I might invent some sort of perpetual Kalendar of the *Siddhanta Chandra Mana*, which would supersede the necessity of referring to the Native *Sastras* on any questions of time, and answer all the common purposes of office. Nay, after the present Memoir had already assumed some consistency, a scientific friend objected that it was rather a Tract on Hindu Astronomy than on the Kalendar, and recalled my attention to the original design of the research: But after a perusal of all

that he could collect on the same subject, he ultimately admitted (as I trust every person who has read with attention the preceding pages will) that any attempt to subject the contingencies of the Luni-solar years to any mechanical process, would be as hopeless a task as if it were proposed to elicit the articles of the *English Nautical Almanac*, or *French Connaissance des Temps*, by any other means than their regular computation.

Our point has therefore been gained; namely, that of undeceiving several Gentlemen, well informed in other matters, on a subject respecting which they were much mistaken.

Lastly, if it be at any time of public importance to fix or expound dates according to Luni-solar account, having now disclosed the means by which these questions are resolved by the Native Sastras themselves, and (with the exception of a few particular contrivances invented by private Kalendar makers) the *only ones* that can answer the same end, I may be permitted to hope, that although the rules here given, be long and harassing in the extreme, yet the Key to the *Siddhanta Chandra Mana* has furnished an instrument for Chronology which was hitherto unknown in this part of India.

END OF THE SECOND MEMOIR.



APPENDIX

TO THE

KEY TO THE SIDDHANTA CHANDRA MANA.

—•••••
A COMMENTARY

ON

VAVILALA CUCHINNA'S

RULES AND TABLES FOR COMPUTING THE TELLINGA KALENDAR.

—•••••
Written in the year 1797.
—•••••

THE following Commentary on Vavilala Cuchinna's Rules and Tables, is inserted here, rather as a Tract extremely remarkable, both for the singularity of the topics which it investigates, and for the ingenuity displayed in expounding them, than as an instrument which is likely to prove servicable to the main object of these Memoirs. Such documents should be kept on record, although they be seldom referred to; because they may lead into unexpected discoveries, and teach better than any series of precepts, how to unravel the manner of reasoning of a people who have frequently found their way to truth by paths widely different from those usually followed by European philosophers.

It may be said of this Tract, that presented by itself, it would throw but little light on the theories of Hindu Astronomy. The contrivance of an arbitrary Index for using the Tables of the Planets, and other Elements, is in particular, calculated to throw a veil over the problems to be resolved, which nothing short of the penetration and perseverance of the scholiast who undertook the trying task of exploring them could ever have removed. But I trust that those who have perused the two first Memoirs of the *Kala Sankalita*, will find no difficulty in tracing back the rules contained in the following pages to their legitimate source.



RULES AND TABLES

For computing the principal articles of the Hindu Luni-solar Kalendar for the Meridian of Lanka reducible to any other Meridian, communicated to A. SCOTT, Esq. by JOSELA BARCARJOSEY of the Village of Salluxeram near Chicacole, in the year 1797. ()*

PART I.

1. On the last day of the Tellinga year which ended on the 28th March 1797 at noon, 4895 years of the Cali yug expired, and also 1712 years of the æra of Salivahana: the Epoch from which the computations commence is the end of the 1220th year of the æra of Salivahana, or 499 years before the commencement of the present Tellinga year.

2. To find the number of days elapsed from the given Epoch to the beginning of the Tellinga year answering to the 28th March 1797 at noon.

Aharas from Epoch.

1 ^o	2 ^o	3 ^o	4 ^o
499	5988	5988	6172
12	86	184	30
<hr/>	<hr/>	<hr/>	<hr/>
5988	6074	6172	185160
41	15		304
<hr/>	<hr/>		<hr/>
70)5029(80	33)6039(184		708)185464(261
6020	6072		184788
<hr/>	<hr/>		<hr/>
9	17		676
 5 ^o	 6 ^o	 7 ^o	
185160	185160	7)182262(26037	
261	2897	182262	
<hr/>	<hr/>	<hr/>	
185421	182263		4
13			
<hr/>			
61)185434(2897			
185403			
<hr/>			
26			

It appeared on consideration, that the number 6172 found by the 3d operation, is that of the

(*) The first part of this Treatise refers to the XXXVth, XXXIXth, XLth, and XLth Tables.

Lunar months contained in 499 years; and that the number 182263 found by the 6th operation, is that of the number of days in the same period of years. The days divided by 7 shew that 26037 weeks had elapsed and four days over, and as the Epoch was on a Friday, the last day of the last Telhinga year fell on a Tuesday. From a consideration of the operations, I find that 385 years answer to 4762 Lunations, and that 7552 Lunations answer to 223015 natural days, without a remainder in either case. By combining these, it is found that 2907520 years answer exactly to 25062624 mean Lunations, and also exactly to 1061997430 natural days.

Ratio of the Sun's
Zodiacal revolution
to mean Lunations
in the same.

It follows that one Zodiacal revolution of the Sun contains 12.3686312 mean Lunations; that a mean year or Zodiacal revolution of the Sun contains 365.2588563 days, that is $365^{\circ} 45' 31'' 38'' 96$ as the Indians reckon, or $365^{\circ} 46' 12'' 45'' 18''$ as Europeans reckon; that one mean Lunation contains 29.5303879 days, that is $29^{\circ} 31' 50'' 0.99$, or $29^{\circ} 12' 44'' 2.79$; and that one mean Zodiacal revolution of the Moon contains 27.3216747 days, that is $27^{\circ} 19' 18'' 1.66$ or $27^{\circ} 7' 43'' 12'' 66''$.

Tidhis or Lunar-solar
days.

A Tidhi or the 30th part of a Lunation is on a medium equal to 0.9843529 of a day, or to $59^{\circ} 3' 40'' 23$, so that 64 mean Tidhis are nearly equal to 63 days. It also appears that 34 mean Lunations or Lunar months are nearly equal to 33 Solar months or 12th parts of the Sun's revolution in the Zodiac. Since the last Telhinga year ended 28th March 1797 N. S. or 17th March O. S. at noon, and since 182263 days had elapsed from the Epoch to the end of last year, it follows that the Epoch answers to Friday the 14th March 1298; for 182263 days make 499 Julian years, including 125 Bissextiles, and 3 days over.

For the Prabhata
or Padyami Tidhi.

3. To find the mean time of the first Tidhi Padyami's beginning, or in other words the mean time of new Moon.

This is only a continuation of the computation at the beginning of the last article; by that the day of the new Moon was found, but this serves for finding the time of the day.

1 st	2 nd
676	64 0 0 0
60	26 57 17 17
708)10560(57	64)37 2 42 420
40356	60
204	2221(34
60	2176
)12240(17	46
12036	60
204	2802(43
60	2752
)12240(17	50
12036	60
204	3012(47
	3008
	35

The remainder left in the 4th operation of the last article is first reduced to sexagesimal parts, and joined to the remainder left in the 5th operation, of which it makes a part; as the quotient of the 5th operation is however subtractive in the 6th, its remainder including the fractional part, is first subtracted from its divisor 64, and then the difference reduced to sexagesimal fractions of a day. The result shews, that the time of the mean new Moon at the original Meridian, was the 27th March at $34^{\circ} 43' 47''$ after noon.

$$\begin{array}{r} 36 \\ 80)720 \\ 60 \end{array}$$

$$\begin{array}{r} 4500(56 \\ 4480 \\ \hline 20 \\ 60 \end{array}$$

$$\begin{array}{r} 1200(15 \\ 1200 \end{array}$$

The method here used for finding the allowance to be made for the difference of Meridian, is equivalent to this proportion. As the circumference of the Parallel of Latitude or 4800 yojanas, is to a day or 60°, so is 75 yojanas which we are to the Eastward of the original Meridian, to 56° 15'.

Difference of Meridian.

$$\begin{array}{r} 36 \\ 34^{\circ} \quad 45' \quad 47'' \\ 55 \quad 15 \\ \hline 35 \quad 40 \quad 2 \end{array}$$

The time of mean new Moon is therefore considered to have happened at the place where we now are, at 35° 40' 2" after noon of the 27th March.

Time of new Moon sought.

N. B.—It was often long before I could discover the objects which the following operations aimed at, and indeed I had gone thro' the whole method and seen to what purposes the computed numbers were applied, before I could form any conjecture about what was intended.

4. To find the number of mean Zodiacal revolutions of the Moon from the given Epoch to the beginning of the Tellinga-year answering to the 23th March.

For the mean Zodiacal revolutions of the Moon from the Epoch.

$$\begin{array}{r} 10 \\ 182263 \\ \hline 10 \times \\ \hline 1822630 \\ 2300 + \\ \hline 1824930 \\ 1814128 \\ \hline 11002 \end{array}$$

$$\begin{array}{r} 27 \\ 182463 \\ 137 \\ \hline 182400 \\ 69 + \\ \hline 85)182459(2140 \\ 182410 \\ \hline 59 \end{array}$$

$$\begin{array}{r} 36 \\ 182263 \\ 2146 \\ \hline 180117 \\ 1 \\ \hline 27)180116(6670 \\ 180000 \\ \hline 26 \end{array}$$

The number 182263 is that of the natural days from the Epoch to the beginning of the present year, and when it had been discovered that the number 180116 in the 3d operation was Nacshatras, it was easy to find that the Moon is supposed to describe 556243 Nacshatras in 562670 days exactly. The mean time of the Moon's describing one Nacshatra is therefore 1°.0119139 or 1° 0' 42" 53' 39". As 84 Nacshatras answer nearly to 85 days, it follows that if to a small Arc expressed in Nacshatras and sexagesimal parts, be added its 84th part, we have the time in which that Arc will be described, by the Moon, expressed in days and sexagesimal parts.

Having also discovered that the quotient 6670 in the 3d operation is that of the Zodiacal revolutions, it is easy to see that the Moon is supposed to complete exactly 556243 Zodiacal revolutions in 15197490 days; one Zodiacal revolution of the Moon is therefore equal to 27.32167116 days, that is 27° 19' 18" 1" 62, or 27° 7' 43' 12" 65.

For the Moon's mean place in the Zodiac at the beginning of the year.

5. To find the Moon's mean place in the Zodiac at the beginning of the year.

The computations in the last article shewed that the Moon had completed 6670 Revolutions and almost 26 Nacshatras over. The remainders left in those operations, are here reduced to sexagesimal fractions.

1 ^a	2 ^a
11002	59 49 50 34
60	60
13244)66012(49	84)3569(42
646256	3328
11164	61
60	60
3559840(50	3770(44
602200	3696
7640	14
60	60
458400(34	574(10
450290	840
8104	34

If the second divisor had been 85, as in the last article, the quotient would have been sexagesimal fractions of a Nacshatra; but by dividing by 84 instead of 85, and thereby increasing the quotient, one 24th part, it follows from what was before remarked, that instead of the fraction of a Nacshatra, we get the time in which it is described. As this quotient is subtractive, it shews that in 42° 44' 10" the Moon will complete the 25th Nacshatra at the original Meridian, and adding 56° 15', (3) gives 43° 40' 25" for the time after noon, at the place where we now are, of its completion.

For the number of mean periods of Yogas from the Epoch.

6. To find the number of mean periods of Yogas from the given Epoch to the beginning of the present Tellinga year.

1 ^a	2 ^a	3 ^a
182263	182263	182263
7 ×	1031	11527
1275841	181234	193390
618 ÷	2 ÷	3
1238)1276459(1031	10)181234(11327	27)193387(7160
1276378	181232	193363
81	2	24

The number 193387 in the 3d operation being supposed the Nacshatras which the sum of the mean motions of the Sun and Moon amount to in 182263 days, I find that the sum of the mean motions of the Sun and Moon in 19308 days will be exactly 21039 Nacshatras. The mean time of a Yoga is therefore .9414896 of a day or 56° 29' 21" 75, and 17 mean Yogas nearly equal to 16 days.

In 534816 Days there will be 21039 mean revolutions or periods of all the 27 Yogas.

7. To find the mean time when the 25th Yoga will end.

By the last computation it appears that 24 Yogas were completed and the 25th begun.

For the mean time when the 25th Yoga ends.

16	23
81	16
60	2
1133)4800(3	11 3 55 32
3714	60
1146	13)843(49
60	853
68700(53	10
68090	60
670	655(38
60	646
40200(32	9
39516	60
684	572(33
	561
	11

8. To find the number of Anomalistic revolutions of the Moon from the Epoch to the beginning of the present Tellinga year.

16	23
185160	555480
3 ×	146
555480	555625
614 +	49 +
3784)555609(146	84)555675(6615
552464	555600
3630	15

malistic revolutions. One Anomalistic revolution of the Moon is therefore equal to 27,992,602.4 Tiddhis, or 27,534,600 natural days, that is 27° 33' 16" 33' 62" or 27° 13' 18" 37' 55".

9. To find the Moon's mean Anomaly, expressed in terms adapted to the Index of the Tiddhi Table, for the mean time of new Moon.

3630
80
8784)390400(76
287584
2816
60
108960(44
166496
2464

The first remainder in the last computation is multiplied by 80, but the following fractions are sexagesimal parts of it. The quotient thus found is joined to the second remainder in the last computation, and gives 15 76.44 for the Index required.

Each unit in the first term of this *Index* is the 84th part of one Ano- malistic revolution of the Moon, or 328th of a natural day. Each unit of the second term being one 80th part of the first, is .041 of a natural day, or .246 of a guddia. To reduce guddias to the 246th part of a guddia, multiply

by 4, and to the product add its 60th part. Thus if 15 be given, then $4 \times 15 \times \frac{4 \times 15}{60} = 61$, and 61 : is to 15 :: as 1 : to 246 nearly. The reason of this remark will appear hereafter,

The quotient 3 55 32 is properly subtractive from 2 the remainder in the second operation in the last article, but the complement of the whole to the former divisor 16 is here taken, because it is not the time since the 24th Yoga ended, that is required, but the time until the end of the 25th Yoga. The dividing by 17 instead of 16 gives the second quotient 49° 38' 33" in time, to which adding 59° 15' on account of Meridian distance, we get 50° 34' 48" for the mean time of the end of the 25th Yoga after noon.

For the number of Anomalistic revolutions of the Moon from the Epoch.

The number 183160 on which this computation is founded, appears to be that of the Tiddhis elapsed from the Epoch to the beginning of the year (art. 2, no. 4), and having found out that the quotient 6615 must be that of the Anomalistic revolutions of the Moon, it follows that 105652 Tiddhis are equal to 3785 Ano-

For the Moon's mean Anomaly in terms of the Index of the Tiddhi Table XXVII.

Index of Tables for the Moon's mean Anomaly 15 76.44.

For the number of
mean Anomalistic
revolutions of the
Sun from the Epoch.

10. To find the number of Anomalistic revolutions of the Sun from the Epoch to the beginning of this year.

To	20
185160	185160
1900 +	32
5720)187060(32	185128
183040	92 +
4020	371)185220(499
	189129
	91

From this computation I find that 3719 Anomalistic revolutions of the Sun are supposed equal to 2122130 Tiddhis, so that one Anomalistic revolution must be 371.0013714 Tiddhis or 365.2587933 natural days; that is 365° 15' 31' 39" 46" or 365° 6' 12' 39" 78".

For the Sun's mean
Anomaly for the
mean time of new
Moon in terms of
the Index.

11. To find the Sun's mean Anomaly for the mean time of new Moon expressed in terms adapted to the Index of the Solar Table.

To
4020
10 ×
5720)10200(7
40040
160
60
10600(1
5720
3880

Index of the Solar
Table XL, 90 & 59.

The quotient is subtracted from the second remainder in the last computation, and leaves 90 2 59 for the Index required.

Each unit in the first term of this Index being the 371st part of one Anomalistic revolution of the Sun, or .9845 of a natural day; each unit of the second term will be .09845 of a day or 3.907 guddias. To reduce guddias to the scruples of time expressed by the second term of the Index, divide by 6, and to the quotient add its 60th part. Thus if 19 be given, then $4\frac{1}{2} \times \frac{18}{6 \times 60} = 30\frac{1}{2}$, and 18 is to 3.05 as 3.902 to 1 nearly.

To find the Index to
the Nacshatra Table
XXXVIII

12. To find the Index to the Nacshatra Table for the mean time of the Moon's completing the 26th Nacshatra.

To	20	30
43° 40' 25"	15 76 44	16 22 18
35 40 2	32 34	62 20
8 0 23	41)16 20 16(0 62 20	15 46 53
4 ×	10 29 0	
32 1 22	18	
32 1		
32 33 33		

From the time of the Moon's completing the 26th Nacshatra (5) subtract the mean time of new Moon (3) which shows the former to be

58 or 23" later than the latter. Multiply this difference by 4 and to the product add its 60th part (9), which gives 34 31 nearly for the increase answering to that time.

To the Index of the Tiddhi Table for the mean time of new Moon (9), add the increase thus found, and it gives the Index of the Tiddhi Table for the time of the Moon's completing the 26th Nacshatra 16 29 18.

The Index of the Tiddhi Table being expressed in 34th parts of the circumference of a Circle, and the Index to the Nacshatra Table being expressed in 80th parts of the same, the Index of the

former must be diminished four 84th parts, or one 21st part, in order to adapt it to the latter Table.

This correction being made, gives 15 46 53 for the Index to the Nacshatra Table at the given time. Index to the Nacshatra Table 15 46 53.

13. To find the Index to the Yoga Table for the mean time of the end of the 25th Yoga, or for 40^h 34^m 48^s after noon (7). To find the Index of the Yoga Table XXX (X) 17 9 13.

1 st	2 ^d	3 ^d
50 34 48	15 78 44	16 57 23
35 40 2	60 39	31 50
14 54 45	42 10 57 23 (0 31 50	17 9 13
4 ×	16 57 0	
59 39 4	23	
59 39		
60 38 43		

This computation is the same in principle with the last, only that as the Index to the Tidhi Table is expressed in 84th parts of the circumference, and the Index to the Yoga

Table in 86th parts of the same, the Index of the former must be augmented two 84th parts, or one 42d part, in order to adapt it to the latter Table.

14. The four Tables made use of in this method, are next to be considered.

The XXXVIIth or Tidhi Table, answers to an Anomalistic revolution of the Moon, and as its Index increases to 84, each unit thereof is nearly one third of a Tidhi, there being 27.0926 Tidhis in an Anomalistic revolution (8). For each Tidhi, therefore, the Index to this Table must be increased 3 0 4. The first column after the Index seems to be that of the Moon's Equation converted into time by the following proportion, viz. as the Moon's true diurnal motion minus the Sun's mean diurnal motion, is to the Moon's Equation expressed in degrees, &c. so is 60^z or a natural day to the Equation inserted in the Table. The last column seems to be that of the true diurnal motion of the Moon minus the mean diurnal motion of the Sun expressed in degrees, &c. Table XXXVII

The XXXVIIIth or Nacshatra Table, answers also to an Anomalistic revolution of the Moon, and as its Index increases to 80, each unit thereof, is nearly one third of the time in which the Moon describes a Nacshatra. Hence, as an Anomalistic revolution or 27° 55' 44" (3), is to 80, so is the time of describing a Nacshatra or 1°.01101 (4) to 2.9379 or 2 75 2, the increase of the Index of this Table answering to one mean Nacshatra. The other column seems to be that of the Moon's Equation converted into time by this proportion, viz. as the Moon's true diurnal motion, is to her Equation expressed in degrees, so is 60^z, to the Equation inserted in this column. Table XXXVIII

The XXXIXth or Yoga Table, answers still to an Anomalistic revolution of the Moon, and as its Index increases to 86, each unit thereof answers to one third nearly of the time of a mean Yoga. Hence 27° 55' 45", is to 86, as the time of a Yoga, or .94149 (5), to 2.9385 or 2 75 4, the increase of the Index for one Yoga. The first column after the Index seems to be that of the Moon's Equation Table XXXIX

converted into time, by the following proportion, viz. as the Moon's true diurnal motion plus the mean diurnal motion of the Sun, is to the Moon's Equation expressed in degrees, &c., so is 60^g to the Equation inserted. The last column appears to be that of the true diurnal motion of the Moon plus the mean diurnal motion of the Sun.

Table XI.

The XI. st, or Solar Table, answers to an Anomalistic revolution of the Sun, and as it increases to 371, each unit thereof answers nearly to one Tidhi. The first column after the Index seems to be that of the Sun's Equation expressed in degrees, &c. (in the original it was expressed in seconds), but by the manner in which it is used, the Sun's Anomaly seems to be reckoned from the Perigee and not the Apogee. The last column is that of the semi-diurnal Arcs expressed in time.

For the true time of
new Moon.

15. To find the true time of new Moon, or of the beginning of the first Tidhi Padyami.

(15 76 44) Refer to the Tidhi Table with the Index before found (9), and take out the corresponding numbers, with the proportional parts.

6 23^s 49^o (3 58 4
23 48 4
1 4 2) The Lunar Equation being additive, the Index to the Solar Table before found (11) requires an augmentation proportioned thereto. Divide therefore the Lunar

Equation by 6, and to the quotient add its 60th part, which gives the correction to be added to the Index to the Solar Table before found.

(60 7 1) With the Index thus corrected, refer to the Solar Table, and take out the corresponding numbers from both columns.

710 7823 (11) Divide the Sun's Equation expressed in seconds, by the number taken out of the last column of the Tidhi Table expressed in minutes, (they are so inserted in the original Tables) and the quotient is guddias and siguddias of time. In other words, say, as the Moon's diurnal motion from the Sun, is to 60^g, so is the Arc expressed by the Sun's Equation, to the time in which it will be described.

To the mean time of new Moon (3), add the Lunar Equation, and also the Solar Equation reduced to time, and the sum shows the true time of new Moon to fall on the 28th March at 10^h 30^m after noon, and by adding the semi-diurnal Arc, that it fell on the 28th March at 21^h 14^m after Sun rise.

For the true time of
the end of the 26th
Nacshatra.

16. To find the true time of the end of the 26th Nacshatra, or the beginning of the 27th named Revati.

(15 46 58) Refer to the Nacshatra Table with the Index before found (12), and take out the corresponding Equation.

0	43	40
0	22	9
1	5	49
0	14	44
1	20	33

To the mean time add this Equation, and also the semi-diurnal Arc, which shews that the 27th Macshatra began on the 28th March at 5g 49^r after noon, or at 20g 33^r after Sun rise.

17. To find the true time of the end of the 25th Yoga, or beginning of the 26th named *Indra*. Refer to the Yoga Table with the Index before found (12), and take out the corresponding number including the proportional parts.

50g	34 ^r	48 ^p
35	40	2
14	54	40
20	47	0

6)35	41	40	5	57
	35	42	0	5
			6	2

90	2	59
	6	2

90	9	1
----	---	---

90	9	1
2	10	25 ^r

835)7625(9
7515
110
60
318600(22
18370
230

0	50	34
0	20	47

1	11	21
0	9	22

1	1	50
0	14	44

1	16	43
---	----	----

The Index to the Solar Table is here not only to be augmented on account of the Lunar Equation, but also on account of the difference between the mean time of new Moon (3) and the mean time of the Yoga, or for 35g 42^r in all; and the correction found by article 11 is to be added in the present instance, to the Index to the Solar Table before found.

Refer to the Solar Table with the Index thus corrected, and take out the corresponding Equation.

Divide the Sun's Equation expressed in seconds, by the last number taken out of the Yoga Table expressed in minutes, as in article 15th; or say, as the sum of the diurnal motions of the Sun and Moon, is to 60g, so is the Sun's Equation to the time corresponding.

To the mean time of the Yoga (7), add the Lunar Equation, and from the sum subtract the time answering to the Solar Equation. Add also the semi-diurnal Arc, and the result shews that the 26th Yoga began on the 28th March at 1c 59^r after noon, or at 16g 43^r after Sun rise.

For the true time of the end of the 25th Yoga.

For the Carna is the beginning of the year.

18. To find the Carna for the beginning of the year.

Thirty Tithis having elapsed since the preceding new Moon, multiply this number by 2, because a Carna is half a Tithi; and subtract one from the product, because the first Carna begins in the middle of the first Tithi. As 59 Carnas have passed since the series began, divide this number by 7, and the quotient 8 shews that so many complete series of the seven ordinary Carnas have passed, and the remainder, that three of the four extraordinary Carnas are also past. The last of the eleven Carnas, or

30
2
60
1
7)59(8
56
3

the fourth extraordinary Caru begins with the first Tidhi, or at 21^h 14' after Sun rise on the 28th March, as already found (15).

For the mean time of the beginning of the 2d Tidhi.

19. To find the mean time of the beginning of the 2d Tidhi, 23th Nacshatra and 27th Yoga; or end of the 1st Tidhi, 27th Nacshatra and 26th Yoga.

Tidhi.				Nacshatra.				Yoga.			
n.	a.	r.	p.	n.	a.	r.	p.	n.	a.	r.	p.
0	35	40	2	0	43	40	25	0	50	34	48
0	59	3	40	1	0	42	53	0	56	29	22
<hr/>				<hr/>				<hr/>			
1	34	42	42	1	44	23	18	1	47	4	10

This is simply to add the mean time of one Tidhi, one Nacshatra and one Yoga (2, 4 and 6) to the mean time of the beginning of the last Tidhi, Nacshatra and Yoga (3, 5 and 7).

For the Indices of the Tidhi, Solar, Nacshatra and Yoga Tables.

20. To find the Indices of the Tidhi, Solar, Nacshatra and Yoga Tables, for the time of the beginning of the 2d Tidhi, 28th Nacshatra and 27th Yoga.

Tidhi.			Nacshatra.			Yoga.			Solar.		
n.	a.	r.	n.	a.	r.	n.	a.	r.	n.	a.	r.
15	70	44	15	45	58	17	9	13	90	2	59
3	0	4	2	75	2	2	75	4	1	0	0
<hr/>			<hr/>			<hr/>			<hr/>		
18	70	48	18	42	0	20	4	17	91	2	59

To the Indices before found (9, 11, 12 and 13) add the increase of each respectively, for one Tidhi, one Nacshatra, and one Yoga (14).

For the true time of the beginning of the 2d Tidhi.

21. To find the true time of the beginning of the 2d Tidhi.

1 ^o	2 ^o	4 ^o	5 ^o	6 ^o
(18 70 48)	0 24 47 4 8	(91 7 11)	725)7827(10	n. a. r.
	24 48		7250	0 31 43
				0 24 47
				0 10 49
a. r.	4 12	2' 10' 27"	577	
24 47		6. r.	60	1 10 18
	3 ^o	14 44		0 14 44
12' 5'	91 2 59		34620(49	
	4 12		34800	1 25 2
	91 7 11			

The 2d Tidhi begins therefore on the 29th March or 1st day of the Tellinga year, at 10^h 18^m after noon or 23^h 2^m after Sun rise.

For the true time when the 23th Nacshatra begins.

22. To find the true time when the 23th Nacshatra begins.

1 ^o	2 ^o
(18 42 0)	n. a. r.
	0 44 23
	0 22 50
a. r.	
22 50	1 7 22
	0 14 44
	1 22 6

It begins therefore on the 29th March at 7^h 22^m after noon or 22^h 6^m after Sun rise.

23. To find the true time when the 27th Yoga begins.

1 ^o	2 ^o	3 ^o	5 ^o	D.	G.	V.
(20 4 17)	47 4 10 34 43 42	21 2 59 5 42	850)7827(9 7650	0 47 4		
			177	0 21 22		
c. 21 22	12 20 28 21 22 0	21 8 41	60	1 8 26		
14' 10'			10620(12 10200	0 59 14		
	0)33 42 28(5 37 33 42 0 5	21 8 41	420	0 14 44		
	28 5 42	2 10 27		1 13 58		

For the true time when the 27th Yoga begins.

The 27th Yoga begins therefore, on the 29th March at 13^h 58^m after Sun rise.

24. To find the Carna.

A Carna being half a Tidhi, the computation of the former differs in nothing from the computation of the latter; only that instead of advancing by a mean Tidhi at a time, as in art. 19, no. 1, we must only advance by half a mean Tidhi at a time.

For the Carna

In the present instance, it need only be observed that the 2d Carna begins with the 2d Tidhi.

25. To find the Wurjum next after the new Moon.

1 ^o	2 ^o	3 ^o
1 ^h 22 ^m 6 ^s 0 20 33	30 ^h 45 ^m 20 33	
1 1 33 30	51 19 29 28	
60)30 46 30(30 46 30 46 0	21 51	

From the time when the 25th Nacshatra begins (22), subtract the time when the 27th begins (16), and the difference 1^h 1^m 33^s is the time in which the Moon describes the 27th Nacshatra: then say, as 1^h or 60^m, is to the time of the Moon's describing it, so is 30^m the Drava of the 27th Nacshatra to the time of the Moon's describing that Arc, viz. 30^m 46^s.

To the time thus found, add the time of the Moon's entering the 27th Nacshatra; which shews that the Wurjum began 51^m 19^s after Sun rise, and subtracting double the semi-diurnal Arc, that it began 21^m 51^s after Sun set.

The Thyajum or continuance of the Wurjum, is reckoned to be 4^h of time.

The Thyajum 4 god. hrs. of time.



PART II.

Method of computing the mean and true places of the Planets in the Zodiac, by means of Astronomical Tables.

1. No Tables are made use of in the Surriah Siddhanta, but modern Astronomers often make use of Tables, and as I have been told that *Vavilala Cochanna's* Tables agree very well with the Rules given in the Surriah Siddhanta, I shall insert them here, according to the copy which I obtained.

Epoch of Vavilala
Cochanna's Rules
and Tables.

It has already been observed, that those who use these Tables commence their computations from noon of the last day of the 4390th year of the Cali yug, for which Epoch, Vavilala has given the *Druvas* or mean places of the Planets, and their higher *Apsides*.(*) I have no doubt that he gave the places of the ascending Nodes for the same time, but as I did not obtain this information from my Instructor, I endeavoured to supply it otherwise. Indeed the person from whom I procured a copy, did not know the use of the last column of the Tables for the Annual Equations of the Planets, which I found to be the *Chila Carna*, and necessary, (according to the method taught in the Surriah Siddhanta,) for finding the Latitudes of the Planets.

2. *Druvas* or mean places of the Planets, their *Apsides*, and Nodes, for noon of the last day of the 4390th year of the Cali yug.

Mean place of the
Planets on the last
day of the 4390th
year of the Cali yug,
called their *Druvas*.

Planets.	Mean place:					Apsis.				Node.			
Sun	-	-	41	15	26	31	23	2	17	16	19	3	
Moon (+)	-	-	11	5	48	37	29	4	15	26	17	0	6 12 9
Mars	-	-	0	22	35	27	41	4	10	2	5	1	10 3 42
Mercury	-	-	10	26	48	8	46	7	10	27	18	0	20 42 4
Jupiter	-	-	10	15	45	15	40	5	21	10	48	2	19 40 35
Venus	-	-	8	22	20	19	15	2	19	50	45	1	29 41 56
Saturn	-	-	2	28	53	31	36	7	26	37	27	3	10 22 39

Motion of the *Apsides*.
do.

The motion of the *Apsides* of the Planets was stated to me as follows: Sun's *Apogee* 1' in 517 years. Mars' *Apsis* 1' in 980 years. Mercury's do. 1' in 544 years. Jupiter's do. 1' in 222 years. Venus' do. 1' in 374 years. Saturn's do. 1' in 5123 years.

(*) Vide Appendix at the end of the Note.

(†) The Moon's *Apogee* and *Node* are subject to a *Bijah* or correction of 4 revolutions in a *Maha yug*, as was shown in the Second Memoir, Part II; but the *Tellichy* Astronomers do not seem to make use of it. This *Bijah*, with its *Druvas*, will be found in Table XXII.

The motion of the Nodes, according to the rules given in the *Sarriah Siddhanta*, may be stated as follows: Mars' Node 1' in 935 years. Mercury's do. 1' in 410 years. Jupiter's do. 1' in 1149 years. Venus' do. 1' in 222 years. Saturn's do. 1' in 302 years. It is to be remembered, that all the Nodes are supposed to have a retrograde motion.

In finding the *Ayanansa*, or distance between the vernal Equinoctial point and beginning of *Mesha R.* at a particular time; it is only to be remembered, that these points are supposed to have been coincident at the expiration of the 3600th year of the *Calī yug*, and that the Equinoctial points have a retrograde motion at the rate of 54' in one Sydereal year. To find the *Ayanansa*, therefore, for the end of the 4599th year of the *Calī yug*, we have $4299 - 3600 = 1299$, and $1299 \times 54' = 19^{\circ} 29' 6''$, which is but little different from the *Ayanansa* for the same period found by the former method.

3. A. To find the mean place of the Sun, for the mean time of midnight, at the beginning of the 4900th year of the *Calī yug*, under the meridian of *Lanka*. From the expired years 4899 of the *Calī yug*, subtract 4899 years (63), and find the number of days contained in the difference, which is 182618 (*). Then the Sun's mean motion for this number of days, 500 will be found by the Table, as follows:

	°	'	''	'''
100000	9	10	15	56
80000	0	8	12	44
2000	5	21	12	19
400	7	21	21	42
10	0	9	51	22
8	0	7	53	5

The Sun's mean motion in 182618 days, is therefore found to be $11^{\circ} 15' 47'' 8'''$.

Sun's mean motion from Epoch, Index to Solar Table.

182618 11 18 47 8

°	'	''	'''
11	18	47	8
11	15	26	54
11	4	13	42
0	0	29	54
11	4	43	16

To the Sun's mean motion for 182618 days, add the *Druva* (2) and this gives his mean place at noon of the last day of the 4899th year of the *Calī yug*, to which adding half the Sun's diurnal motion, we get his mean place for midnight, or the beginning of the 4900th year of the *Calī yug*.

Sun's mean place at Lanka for mean midnight at Lanka.

B. To find the place of the Sun's Apogee for the beginning of the 4900th year of the *Calī yug*.

As the Sun's Apogee moves at the rate of 1' in 517 years (3), we have $\frac{1' \times 500}{517} = 58''$ for its motion in 500 years.

(*) The manner of finding the Index to Yavilala Cuchiana's Tables was given in Part III, Article 2 of the 2d Memoir. In the present case it will be

$$I. \frac{66389 \times 500 + 85211}{180000} = 184 \text{ Adigah months, and } 18 \times 500 + 184 = 9184.$$

$$II. \frac{6270597 \times 6184 - 3575864}{1359834} = 2902 \text{ Chaya Tithis, and } 30 \times 6184 - 2902 = 182618 \text{ Bhumi kavan days, the Index sought.}$$

Place of the Sun's Apogee. $\begin{array}{r} 2 \ 17 \ 16 \ 10 \\ 58 \\ \hline 2 \ 17 \ 17 \ 17 \end{array}$ To the Drava or place of the Sun's Apogee at the Epoch, add the motion of his Apogee in 500 years, and this gives the place of his Apogee at the time required.

True or apparent Elements. C. Given the Sun's mean place $11^{\circ} 4' 43''$, and the place of his Apogee $2^{\circ} 17' 17''$; to find his true place.

Table XXII. $\begin{array}{r} 2 \ 17 \ 17 \\ 11 \ 4 \ 43 \\ \hline 3 \ 12 \ 34 \end{array}$ 10. With the Argument $3^{\circ} 12' 34''$ refer to the Sun's Anomalistic Table (5) and take out the corresponding Equation $+ 2 \ 7$.

Sun's true place for mean midnight. $\begin{array}{r} 11 \ 4 \ 43 \\ + 2 \ 7 \\ \hline 11 \ 6 \ 50 \end{array}$ To the Sun's mean place for the mean time of midnight, apply the Equation with its proper Sign, and it gives his true place for the mean time of midnight.

Sun's true place and true midnight Area Bhagabala. 20. For the Area Bhagabala, take the 365th part of his Equation $+ \frac{2^{\circ} \ 7'}{365} = 20''$, which being less than $1'$, is here neglected.

Sun's mean diurnal motion $59^{\circ} \ 8'$. D. Given the Sun's mean diurnal motion $59^{\circ} \ 8'$; to find his true diurnal motion.

Table XXII. The Tabular increase of the Sun's Equation for $3^{\circ} 45'$ answering to the Argument $3^{\circ} 12' 34''$ is $1^{\circ} 53'$, hence $\frac{1^{\circ} 53' \times 59^{\circ} \ 8'}{3^{\circ} \ 45'} = 30'$ is the Equation sought.

$\begin{array}{r} 59^{\circ} \ 8' \\ 30' \\ \hline 59 \ 38 \end{array}$

The Sun being nearer his Perigee than his Apogee, the Equation is additive.

The Moon, Table XXI, mean Elements. 4. A. To find the mean place of the Moon, as also of her Apogee and Node, for the beginning of the 4900th year of the Cali yug, and Meridian of Lanka.

First find the motion of each respectively for 182618 days, and then add the Drava (4 3).

	Days.	Moon.				Apogee (°)				Node.			
	100000	1°	5'	12	55	11°	5'	17	27	8°	15'	28	52
	80000	0	28	10	18	9	0	37	53	9	8	47	6
	2000	2	12	42	15	7	12	43	57	3	15	58	11
	600	11	15	48	41	2	6	49	47	1	1	47	27
	10	4	11	45	49	0	1	6	50	0	0	31	48
	8	3	15	21	39	0	0	53	23	0	0	25	23
Index.	182618	11	29	4	35	6	0	31	27	10	15	53	50
Drava		11	5	42	37	4	15	25	17	0	6	12	9
Place at Noon		11	4	53	12	10	15	57	44	1	20	13	19
$\frac{1}{2}$ Diurnal motion			6	35	17			3	20			1	35
Place at midnight		11	11	28	29	10	15	1	4	1	20	11	44

Moon's mean place. B. Given the Moon's mean place, and the place of her Apogee; to find her true place.

(*) The Bijak of 4 revolutions in a Maha yug, additive, is here omitted, as already noticed.

$$\begin{array}{r} 11^{\circ} \quad 11' \quad 28' \\ \hline 11 \quad 11 \quad 33 \end{array}$$

1^o To the Moon's mean place for the mean time of midnight, add the 27th part of the Sun's Equation $\frac{2^{\circ} 7'}{27} = + 5'$, for the Arca Bhagabala; Arca Bhagabala, and it gives the Moon's mean place for the apparent time of midnight.

$$\begin{array}{r} 10^{\circ} \quad 16' \quad 1' \\ 11 \quad 11 \quad 33 \\ \hline 11 \quad 4 \quad 23 \end{array}$$

2^o With the Argument $11^{\circ} 4' 23'$, refer to the Lunar Table, and take Table XXIII, out the corresponding Equation $2^{\circ} 11'$.

$$\begin{array}{r} 11 \quad 11 \quad 33 \\ \hline 2 \quad 11 \\ \hline 11 \quad 9 \quad 22 \end{array}$$

From the Moon's mean place corrected, subtract the Equation thus found, True or apparent Elements, and it gives the Moon's true place. Moon's true place.

C. Given the Moon's mean diurnal motion $13^{\circ} 10' 35''$, and her diurnal motion from her Apogee; to find her true diurnal motion.

The increase of the Moon's Equation for $3^{\circ} 45'$ answering to the Argument $11^{\circ} 4' 28'$, is Table XXIII, $13' 4''$; and $\frac{13^{\circ} 3' 54'' \times 18' 4''}{3^{\circ} 45'} = 1^{\circ} 2' 56''$, the Equation sought.

$$\begin{array}{r} 13^{\circ} \quad 10' \quad 35'' \\ 1 \quad 2 \quad 56 \\ \hline 12 \quad 7 \quad 39 \end{array}$$

This Equation, in the present instance is to be subtracted from the mean motion.

D. To find the Moon's Latitude for the time given.

$$\begin{array}{r} 11^{\circ} \quad 9' \quad 22'' \\ 1 \quad 20 \quad 12 \\ \hline 9 \quad 19 \quad 10 \end{array}$$

From the Moon's true place, subtract that of her Node, to get the Argument; the Sine of which is 3247, and the Sine of $4^{\circ} 30'$ the inclination of

the Moon's Orbit, is 270', so that $\frac{270' \times 3247}{3438} = 252'$ is the Sine of the Moon's Latitude and $4^{\circ} 12'$ the Latitude sought, which is South in the present example.

THE PLANETS.

A. To find the mean place of Mars for the beginning of the 4900th year of the Cali yug. Mars, Table XII.

$$\begin{array}{r} 100000 \quad - \quad 6^{\circ} \quad 21' \quad 55'' \quad 16'' \\ 80000 \quad - \quad 5 \quad 11 \quad 33 \quad 1 \\ 2000 \quad - \quad 10 \quad 28 \quad 2 \quad 19 \\ 400 \quad - \quad 10 \quad 14 \quad 24 \quad 42 \\ 10 \quad - \quad 0 \quad 5 \quad 14 \quad 25 \\ 8 \quad - \quad 0 \quad 4 \quad 11 \quad 52 \\ \hline 182618 \quad - \quad 9 \quad 25 \quad 22 \quad 15 \end{array}$$

To Mars' mean motion for 182618 days add the Drava Ahargana from the Epoch or Index, (63) $9^{\circ} 22' 35'' 23''$, and half his mean diurnal motion (68) $0^{\circ} 16' 45''$, which gives $7^{\circ} 18' 13'' 26''$ for his mean place at midnight, at the time given. Mars' mean place at midnight at Lanka.

B. To find the place of Mars' Apse and Node for the same time.

Since Mars' Apse moves at the rate of $1'$ in 980 years (3), we have $\frac{1' \times 500}{980} = 30'$ for its Apse. His Apse. motion in 500 years, and this added to the Drava (63), gives $4^{\circ} 2' 10' 35''$ for its place at the time given.

And since Mars' Node moves at the rate of $1'$ in 935 years (3), we have $\frac{1' \times 500}{935} = 32'$ for His Node.

its motion in 500 years, which subtracted (because the Nodes move retrograde) from the Drove (3), gives $1^{\circ} 10' 8'' 10'''$ for its place at the beginning of the 4000th year of the Cali yug.

For Mars' true place. C. Given Mars' mean place, the place of his Apais, and the Sun's mean place; to find the true place.

1^o To the Sun's mean place apply the 365th part of his Equation before found, and to Mars' mean place apply the 687th part of the Sun's Equation for the Arca Bhagábala; but as these

corrections are each of them less than $1'$, they are omitted.

Arca Bhagábala. $\begin{array}{r} 11 \quad 4 \quad 43 \\ 7 \quad 12 \quad 12 \\ \hline 3 \quad 16 \quad 30 \end{array}$ 2^o From the Sun's mean place, subtract that of Mars, both corrected as above, and with this Argument take out the Equation $+ 37^{\circ} 8'$ from Mars' Annual Table, and apply one half of this to his mean place once corrected, to get it

Twice corrected. $\begin{array}{r} 7 \quad 18 \quad 13 \\ + \quad 18 \quad 34 \\ \hline 8 \quad 6 \quad 47 \end{array}$ *twice corrected.*

$\begin{array}{r} 4^{\circ} \quad 10' \quad 3'' \\ 8 \quad 6 \quad 47 \\ \hline 8 \quad 3 \quad 16 \end{array}$ 3^o From the place of Mars' Apais, subtract his place *twice corrected*, and with this Argument take out the Equation $10^{\circ} 20'$, and apply the half of this to his

Thrice corrected. $\begin{array}{r} 8 \quad 6 \quad 47 \\ 3 \quad 10 \\ \hline 8 \quad 1 \quad 37 \end{array}$ place *twice corrected*, to get his mean place *thrice corrected*.

$\begin{array}{r} 4^{\circ} \quad 10' \quad 3'' \\ 8 \quad 1 \quad 37 \\ \hline 8 \quad 8 \quad 26 \end{array}$ 4^o From the place of Mars' Apais, subtract his place *thrice corrected*, and with this Argument take out the Equation $10^{\circ} 45'$ from the Anomalistic Table, which apply to Mars' place *once corrected*, in order to get his *true Heliocentric*

Table XII., part 2. $\begin{array}{r} 7 \quad 18 \quad 13 \\ 10 \quad 45 \\ \hline 7 \quad 7 \quad 28 \end{array}$ place.

$\begin{array}{r} 11^{\circ} \quad 4' \quad 43'' \\ 7 \quad 7 \quad 28 \\ \hline 3 \quad 27 \quad 15 \end{array}$ 5^o From the Sun's mean place corrected by the Arca Bhagábala, subtract

Part 2. $\begin{array}{r} 7 \quad 7 \quad 28 \\ + \quad 1 \quad 0 \quad 10 \\ \hline 8 \quad 16 \quad 38 \end{array}$ Mars' Heliocentric place, and with this Argument take out the Equation $+ 1^{\circ} 9' 10''$ from the Annual Table, which apply to Mars' Heliocentric place, in order to get his true Geocentric place.

δ true Geocentric place.

For his true diurnal motion. D. Given Mars' mean, to find his true diurnal motion.

Table XII., part 3. $\begin{array}{r} 3521' \\ 3438 \\ \hline 83 \end{array}$ 1^o From the *Chila earns* answering to the Argument $3^{\circ} 16' 30''$, subtract the *Radius*. From the Sun's mean diurnal motion, subtract that of Mars.

58 8

31 26

27 42

Then half the Equation $\frac{27' 42'' \times 26'}{3021} = 29'$ is to be added to, or subtracted from

Mars' mean diurnal motion, according as the Chila carna is greater or less than the

31 26

20

Radius, in order to get his diurnal motion *once* corrected.

Once corrected.

31 48

31' 46"

+1 29

33 15

2^o The increase of the Anomalistic Equation for 3° 45' when the Argument is

8° 3' 10' is 21'; and half the Equation $\frac{31' 46'' \times 21'}{3 \ 45} = 2' 58''$ being added to the

Part 2.

diurnal motion *once* corrected, gives it *twice* corrected.

Twice corrected.

31' 26"

+2 21

33 47

3^o The increase of Mars' Anomalistic Equation for 3° 45' when the Argument

is 8° 8' 26', is 16'; and the Equation $\frac{33' 15'' \times 16'}{3 \ 45} = 2' 21''$ being applied to

Part 2.

Mars' mean diurnal motion, gives his diurnal motion *thrice* corrected.

Thrice corrected.

3438'

3124

314

4^o Take the difference between the Radius and Chila carna answering to 3° 27' 15',

Part 3.

59 8'

33 47

25 21

33 47

2 33

31 14

From the Sun's mean diurnal motion, subtract that of Mars *thrice* corrected.

Then is the Equation $\frac{25' 21'' \times 314'}{3124} = 2' 33''$ to be applied to Mars' diurnal

motion *thrice* corrected, to get his true diurnal motion.

True diurnal motion.

E. To find Mars' Latitude from the foregoing data.

For δ Latitude.

1° 10' 3"

1 9 10

2 19 15

To the mean place of Mars' Node (B), add the annual Equation (C, no. 5),

which gives its corrected place.

Part 2.

Node corrected.

8° 16' 38"

2 19 15

5 27 23

From Mars' true place (C, no. 5), subtract the corrected place of his Node,

and the Sine of the difference is 15 5', Mars' greatest apparent Latitude being

Table XXX.

1° 30', its Sine is 90', and the Chila carna is 3124' (D, no. 4). Hence $\frac{90' \times 133'}{3124} = 4'$ is the Latit. δ true Latitude.

tude sought, which in the present example is North.

A. To find the mean place of Mercury for the beginning of the 4000th year of the Cali yug.

Mercury, Table XLII.

100000 - 9° 1' 48' 16"

80000 - 4 25 20 37

20000 - 8 24 38 10

6000 - 9 25 23 27

1000 - 1 10 55 23

800 - 1 2 44 19

182618 - 11 0 56 12

To Mercury's mean motion for 182618 days, add the Drava

(6 3) 10° 26' 48' 9" and half his mean diurnal motion 2° 2' 46",

which gives 9° 29' 47' 7" for his mean place at midnight at the

time given.

His mean place at midnight at Lanka.

For his Aphelion
and Node,

B. To find the place of Mercury's Apsis and Node for the same period.

Since Mercury's Apsis moves $1'$ in 544 years, we have $(0.3) \frac{1' \times 500}{544} = 25''$ for its motion in 500 years, and this added to the Drupa, gives $7^{\circ} 10' 28' 12''$ for its place at the given period, and since his Node moves $1'$ in 410 years $\frac{1' \times 500}{410} = 1' 13''$ is its motion in 500 years; and this subtracted from the Drupa, gives $0^{\circ} 20' 40' 51''$ for its place at the time required.

For Ψ 's true place,

C. Given Mercury's mean place, the place of his Apsis, and the Sun's mean place; to find Mercury's true place:

1^o Find the Arca Bhagabala for the Sun as before, and to Mercury's mean place add the 88th part of the Sun's Equation, $+\frac{2^{\circ} 2'}{88} = 1'$, which gives $9^{\circ} 29' 48''$ for his mean place once corrected.

Sun's mean place
once corrected.

$$\begin{array}{r} 9^{\circ} 29' 48'' \\ 11 \quad 4 \quad 43 \end{array}$$

XLII, Part 2.

$$\begin{array}{r} 10 \quad 25 \quad 5 \end{array}$$

Twice corrected.

$$\begin{array}{r} 11 \quad 4 \quad 43 \\ 4 \quad 35 \end{array}$$

$$\begin{array}{r} 11 \quad 0 \quad 7 \end{array}$$

$$\begin{array}{r} 7 \quad 10 \quad 28 \\ 11 \quad 0 \quad 7 \end{array}$$

$$\begin{array}{r} 8 \quad 10 \quad 21 \end{array}$$

Part 2.

$$\begin{array}{r} 11 \quad 0 \quad 7 \\ 2 \quad 7 \end{array}$$

Thrice corrected.

$$\begin{array}{r} 10 \quad 28 \quad 0 \end{array}$$

$$\begin{array}{r} 7 \quad 10 \quad 28 \\ 10 \quad 28 \quad 0 \end{array}$$

$$\begin{array}{r} 8 \quad 12 \quad 28 \end{array}$$

$$\begin{array}{r} 11 \quad 4 \quad 43 \\ 4 \quad 16 \end{array}$$

Sun's place four
times corrected.

$$\begin{array}{r} 11 \quad 0 \quad 27 \end{array}$$

$$\begin{array}{r} 9 \quad 29 \quad 48 \\ 11 \quad 0 \quad 27 \end{array}$$

$$\begin{array}{r} 10 \quad 29 \quad 21 \end{array}$$

XLII, Part 3.

$$\begin{array}{r} 11 \quad 0 \quad 27 \\ 8 \quad 5 \end{array}$$

Ψ 's true Geocentric
place.

$$\begin{array}{r} 10 \quad 22 \quad 21 \end{array}$$

His diurnal motion.

D. Given Mercury's mean, to find his true diurnal motion;

2^o From Mercury's mean place, subtract that of the Sun, both once corrected, and with this Argument take out the Equation $9' 11''$ from the Annual Table, one half of which applied to the Sun's place once corrected, gives it twice corrected.

3^o From the place of Mercury's Apsis subtract the Sun's place twice corrected, and with this Argument take the Equation $4' 14''$ from the Anomalistic Table, one half of which applied to the Sun's place twice corrected, gives it thrice corrected.

4^o From the place of Mercury's Apsis, subtract the Sun's place thrice corrected, and with this Argument take the Equation $4'' 16''$ from the Anomalistic Table, and this applied to the Sun's place once corrected, gives the fourth correction of the Sun's place:

5^o From Mercury's place once corrected, subtract the Sun's place four times corrected, and with this Argument take the Equation $8'' 6''$ from the Annual Table, and this applied to the Sun's place four times corrected, gives Mercury's true Geocentric place.

4533 12 From the *Chila-cerna* answering to the Argument $10^{\circ} 25' 5''$, subtract the Part 3.
3438

1005 Radius.

4 5 32
50 8

3 6 24

0 59 8
+ 52 31

1 21 39

1 21 39
+ 1 0

1 22 45

From Mercury's mean diurnal motion, subtract that of the Sun.

Then half the Equation $\frac{3^{\circ} 6' 31'' \times 1005}{4533} = 45' 2''$ is to be applied to the

Sun's mean diurnal motion, in order to get the diurnal motion once corrected. Once corrected.

22 The increase of Mercury's Anomalistic Equation, when the Argument is $3^{\circ} 10' 21''$, being $6'$, for one *Pinda* or $3^{\circ} 45'$, half the Equation

$\frac{1^{\circ} 21' 39'' \times 6'}{3 45} = 2' 11''$ is applied to the mean motion once corrected, to get it twice corrected.

Twice corrected.

0 59 8
1 53

1 0 59

32 The increase of the Anomalistic Equation for $3^{\circ} 45'$ when the Argument is $3^{\circ} 11' 28''$, being $5'$, the Equation $\frac{1^{\circ} 21' 39'' \times 5'}{3 45} = 1' 50''$ applied to the Sun's mean diurnal motion, gives it thrice corrected.

Part 2.

Thrice corrected.

4572
3438

1134 Radius.

4 5 32
1 0 53

3 4 34

1 0 58
+ 45 47

1 46 45

From Mercury's mean diurnal motion, subtract the Sun's thrice corrected.

Then the Equation $\frac{3^{\circ} 6' 31'' \times 1134}{4572} = 45' 47''$ applied to the Sun's diurnal motion three times corrected, gives Mercury's true diurnal motion.

Q's true diurnal motion.

E. To find Mercury's Latitude from the same data.

0 20 41
4 16

0 24 57

0 22 49

0 24 57

0 4 51

To the mean place of Mercury's Node, add the Anomalistic Equation (C, no. 4), which gives the Node's place corrected.

For his Latitude.

His Node corrected.

From Mercury's mean Heliocentric place, subtract the corrected place of his Node, and the Sine of the difference is $8425'$. Mercury's greatest apparent Latitude being 4° , its Sine is $120'$, and the *Chila-cerna* 4572 (D, no. 4). Hence

Table XXX.

XLII, Part 3.

Q's true Latitude.

$\frac{120' \times 8425'}{4572} = 50'$ gives $1^{\circ} 30'$ for the Latitude sought, which in this example is South.

The Elements of \mathcal{M} and \mathcal{S} computed like those of \mathcal{J} ; those of \mathcal{Q} like \mathcal{Q}' .

Note.—The true places of *Jupiter* and *Saturn* are computed in the same manner, *mutatis mutandis*, with that of the Planet *Mars*, and the true place of *Venus* is computed like that of *Mercury*; so that it is needless to add more examples.

A. To find *Jupiter's* mean place for the beginning of the 4000th year of the *Call yug*.

100000 0 29 38 3

20000 5 17 42 27

2000 5 16 11 54

603 1 19 31 28

10 0 0 49 51

8 0 0 39 53

132018 1 24 53 16

To *Jupiter's* mean motion for 182018 days, add the Draca $10^{\circ} 15' 45' 16''$, and half the diurnal motion $2^{\circ} 29'$, which gives $0^{\circ} 10' 41' 1''$ for his mean place at midnight at the time given.

Jupiter, Table XLIII.

Index, \mathcal{M} 's mean Heliocentric place.

His Aphelion,

B. To find the place of Jupiter's Apsis and Node for the same period.

Since Jupiter's Apsis moves $1'$ in 222 years, we have $\frac{1 \times 500}{222} = 2' 15''$ for its motion in 500 years, and this added to the Drava gives $5^{\circ} 21' 22' 3''$ for its place at the given period.

His Node,

And since his Node moves $1'$ in 1149 years, $1 \times 500 = 25''$ is its motion in 500 years, which subtracted from the Drava gives $2^{\circ} 19' 43' 9''$ for its place at the time required.

Venus, Table XLIV

A. To find the mean place of Venus for the beginning of the 4200th year of the Kali yug.

100000	0	14	38	22
80000	0	11	42	22
2000	10	24	17	24
600	8	1	17	16
10	0	15	1	17
8	0	12	49	2
182518	8	20	45	13

To Venus' mean motion for 182518 days, add the Drava $(6\ 3) 8^{\circ} 27' 20' 10''$, and half her mean diurnal motion $48' 4''$, which gives $6^{\circ} 13' 34' 36''$ for her mean place at midnight at the time given.

Index,

Mean place at mid.
night at Lahor,

B. To find the mean place of Venus' Apsis and Node for the same period.

Her Aphelion,

Since Venus' Apsis moves $1'$ in 374 years, we have $\frac{1 \times 500}{374} = 1' 20''$ for its motion in 500 years, and this added to the Drava gives $2^{\circ} 19' 51' 6''$ for its place at the given period.

Her Node,

And since her Node moves $1'$ in 222 years, $\frac{1 \times 500}{222} = 2' 15''$ is its motion in 500 years, and this subtracted from the Drava gives $1^{\circ} 29' 30' 41''$ for its place at the time required.

Saturn, Table
XLV

A. To find Saturn's mean place for the beginning of the 4200th year of the Kali yug.

100000	3	13	55	51
80000	5	5	2	40
2000	2	6	52	33
600	0	20	3	49
10	0	0	20	4
8	0	0	16	3
182518	11	16	37	10

To Saturn's mean motion for 182518 days, add the Drava $2^{\circ} 25' 53' 32''$, and half his diurnal motion $1' 6''$, which gives $2^{\circ} 13' 31' 43''$ for his mean place at midnight at the time given.

Index,

His mean place at
midnight at Lahor,

B. To find the place of Saturn's Apsis and Node for the same period.

His Aphelion,

Since Saturn's Apsis moves $1'$ in 5125 years, we have $\frac{1 \times 500}{5125} = 5''$ for its motion in 500 years, and this added to the Drava gives $7^{\circ} 26' 37' 32''$ for its place at the time required.

His Node,

And since his Node moves $1'$ in 302 years, $\frac{1 \times 500}{302} = 1' 39''$ is its motion in 500 years, which subtracted from the Drava gives $3^{\circ} 10' 23' 0''$ for its place at the time required.

Arca Bhagabala of
the respective Pla-
nets.

In using this method, the Arca Bhagabala for Jupiter is supposed to be the 4334th part of the Sun's Equation; that for Venus the 349th part, and that for Saturn the 10300th part of the Sun's Equation.

These contractions are easily deduced from what was explained in the former section, it being only necessary to divide 360° by the mean diurnal motion of the Planet.

PART III.

*Method of computing the Declination, Ascension, Amplitude, &c. of the Planets,
&c. &c. 2 Fragment*

A. Given the Moon's true place in the Zodiac, her Latitude, and the Ayanansa, to find her Declination. The Moon.

11° 9' 22' 1^o To the Moon's true place, add the Ayanansa, which gives the Moon's
 10 29 Longitude, the Sine of which is 66° and $\frac{49 \times 1397}{3123} = 23$, answers to the Declination of a point of the Ecliptic which has the same Longitude that the Moon has in her own Orbit.
 11 28 51 2^o Because the Moon's Latitude and the Declination just found are both South,
 4 19' their sum is supposed to give the Moon's true South Declination.
 23
 4 40

B. Given Mars' true place, the Ayanansa, and his Latitude, to find his Declination. Mars.

8° 16' 35' 1^o To Mars' true place, add the Ayanansa, which gives his Longitude, the
 19 29 Sine of which is 3416' and $\frac{3116 \times 1397}{2433} = 1389$, which answers to 23° 51'
 9 6 7 the Declination of that point of the Ecliptic which has the same Longitude that Mars has in his Orbit.

23° 51' 2^o From the Declination thus found, which is South, subtract Mars' Latitude,
 4 which is North, and the difference is the Declination sought.
 23 47

Given Mercury's true place, the Ayanansa, and his Latitude, to find his Declination. Mercury.

10° 22' 21' 1^o To Mercury's true place, add the Ayanansa for the Longitude, the
 19 29 Sine of which is 1672; and $\frac{1078 \times 1397}{2433} = 430$, which answers to 7° 17'
 11 11 50 the Declination of the corresponding point of the Ecliptic.
 7 17' 2^o As the Declination of this point and Mercury's Latitude are both South, their
 1 30 sum is to be taken as Mercury's true Declination.
 8 47

NOTE:—Although this method of finding the Declination of the Planets be not perfectly correct, yet the principles on which it is founded, are exceedingly obvious.

The Moon's Declination being supposed 4° 40' South, to find the Ascensional difference.

For the Cshetijya $\frac{982 \times 980}{2229} = 82$, and for the Charajya $\frac{82 \times 3148}{3426} = 82$, which is the Ascensional difference sought.

The Moon's Ascensional difference.

In both this and the last example the second operation might have been omitted, but that is only the case when the Declination happens to be small.

As the reader may be desirous to see how the mean Elements of the Planets are resolved by the Rules of the Sarriah Siddhanta, I shall close this paper with summary examples for each. The manner of deducing their apparent places, therefrom, are the same as those indicated by Vasilata Cochina.

General Problem.

For the mean places
of the Planets.

To find the mean distance of each Planet from the beginning of the Zodiac for the commencement of any year, which let it be that of the 4900th year of the Cali yug (falling on the 19th March 1798) at midnight, under the Meridian of Lanka.

Rule.

The Rule may be expressed as follows:

As the number of Bhumi.savan or natural days in a Maha yug;

Is to the number of Bhagmas, or mean Syderal revolutions of the Planet, in the same time;

So is the Strastidi Digona;

To the number of Revolutions and parts of a Revolution of the Planet in the same time.

N. B.—The complete Revolutions are seldom wanted; but the excess above complete Revolutions, gives the mean place of the Planet from the beginning of the Zodiac.

1st The Strastidi Digona being computed for the end of the Luni-solar year 4899 of the Cali yug, as indicated in the second part of the Key to the *Siddhanta Chandra Manu*, will be found to be 714404086004 Bhumi-seven days, of which there are 1577917823 in a Maha yug.

	Revolutions.	B. Savan days.	Complete Revolutions.	Parts.
☉.	1 st For the Sun's mean place	$\frac{4320000 \times 714404086004}{1577917823}$	$= (1253884893)$	11 4' 43' 18"
☾.	2 nd For the Moon's mean place	$\frac{57157536 \times 714404086004}{1577917823}$	$= (26147848366)$	11 11 28 29
♂.	3 rd For Mars' mean place	$\frac{22068832 \times 714404086004}{1577917823}$	$= (1039893292)$	7 18 13 23
☿.	4 th For Mercury's mean place	$\frac{17937060 \times 714404086004}{1577917823}$	$= (8121042255)$	9 29 47 7
♃.	5 th For Jupiter's mean place	$\frac{264220 \times 714404086004}{1577917823}$	$= (164901018)$	0 10 41 1
♀.	6 th For Venus' mean place	$\frac{3022376 \times 714404086004}{1577917823}$	$= (3179333697)$	5 13 54 36
♄.	7 th For Saturn's mean place	$\frac{146368 \times 714404086004}{1577917823}$	$= (66358628)$	2 15 31 42

For the mean distances of the higher Apuliles from the beginning of the Hindu Zodiac.

For the higher Apuliles
of the Planets.

To find the mean distances of the higher Apuliles and ascending Nodes of the Planets from the beginning of the Zodiac, for the commencement of the 4900th year of the Cali yug, the rule

differs in nothing from that in the last article; only that instead of a *Maha yug*, a *Calpa* (or 1000 *Maha yugs*) is made use of for this purpose; excepting for the Moon.

	Revolutions. Bhumi Savan days.		Apogee. ☉ A
1 ^o For the Sun's Apogee	$\frac{281 \times 714104080004}{1577917828000} =$	(175) 2° 17' 17" 16"	
2 ^o For the Moon's Apogee	$\frac{488003 \times 714404080004}{1577917828000} =$	(221034451) 10 10 1 4	☾ A
	A <i>Maha yug</i>	+ 0 1 38 1	
For the <i>Bijah</i> or correction (*)	$\frac{4 \times 714404080004}{1577917828000}$	Moon's Apogee 10 17 59 5	
3 ^o For Mars' Aphelion	$\frac{931 \times 714404080004}{1577917828000} =$	(92) 4 10 2 35	Aphelion. ♂ A
4 ^o For Mercury's Aphelion	$\frac{988 \times 714404080004}{1577917828000} =$	(166) 7 10 23 12	☿ A
5 ^o For Jupiter's Aphelion	$\frac{906 \times 714404080004}{1577917828000} =$	(407) 5 21 22 3	♃ A
6 ^o For Venus' Aphelion	$\frac{545 \times 714404080004}{1577917828000} =$	(212) 2 10 32 6	♀ A
7 ^o For Saturn's Aphelion	$\frac{38 \times 714404080004}{1577917828000} =$	(17) 7 26 37 32	♄ A

For the place of the Nodes.

The rule is the same as for the upper Apis of the Planets, with this only difference, that they are all supposed to move in *Antecedentia* or retrograde. For the Nodes of the Planets.

	Revolutions. Bhumi Savan days.		
1 ^o For the Moon's Node	$\frac{232298 \times 714404080004}{1577917828000} =$	(105146017) 10° 9' 43" 16"	☾. D.
	A <i>Maha yug</i>	1577917828000	

The *Bijah* the same as for the Apogee + 0 1 33 1

Place of ♀'s Node - - - 10 11 26 17 and its

supplement to 12° is 1° 48' 33' 43".

2 ^o For Mars' Node	$\frac{914 \times 714404080004}{1577917828000} =$	(96) 10° 19' 56' 50" and its supplement	☾. ♂.
to 12° is 1° 10' 3' 10".			
3 ^o For Mercury's Node	$\frac{488 \times 714404080004}{1577917828000} =$	(120) 11 9 19 9 and its supplement	☾. ☿.
to 12° is 0° 20' 40' 51".			
4 ^o For Jupiter's Node	$\frac{174 \times 714404080004}{1577917828000} =$	(78) 9 10 19 51 and its supplement	☾. ♃.
to 12° is 2° 19' 40' 9".			
5 ^o For Venus' Node	$\frac{502 \times 714404080004}{1577917828000} =$	(408) 10 0 20 19 and its supplement	☾. ♀.
to 12° is 1° 29' 39' 41".			
6 ^o For Saturn's Node	$\frac{662 \times 714404080004}{1577917828000} =$	(209) 5 19 39 0 and its supplement	☾. ♄.
to 12° is 2° 10' 31' 0".			

N. B.—The places of the Planets may be resolved from the beginning of the *Call yug* by

(*) The *Bijah* is prescribed by the *Tika*, but not by the *Saurish Siddhanta*.

months of Table XX, XXI, XLII, XLIII, XLIV, and XLV, when the *Abergana* is known. But for the *Aphellions* and *Nodes*, if these Tables be used, the *Epochs* and *Dravas* given at the foot of the Tables must be referred to, and the *Index* must be computed as shewn at Part III, Article 2, of the *Key to the Siddhanta Chandra Manu*.

END OF THE APPENDIX TO THE SECOND MEMOIR.

THIRD MEMOIR.



ON THE

INDIAN CYCLE of 60 YEARS

or

VRIHASPATI CHACRA;

or

CIRCLE of JUPITER.



ADVERTISEMENT.

THE Indian Cycle of 60 years, or *Vrihaspati Chakra*, in any one of its forms, is of little, or no use in the resolution of Astronomical Problems. The Tellinga Astronomers alone, apply theirs to the computation of the years elapsed of the *Call yug*, for finding the *Ahargana* and *Soota dina*, or day of the full or new Moon.

But in a Chronological point of view Jupiter's Cycle is important, because it was ever a practice in Southern India, when dating documents, to annex the name of the year of the *Chakra* to that of the concurrent Solar and *Luni-solar* years; and as we know of three different styles bearing the same denomination, two of which occasionally expunge one *Chakra* year out of the *Kalendar*, whereas the third (also under the name of *Vrihaspati*) records merely common Solar years, without any omission, it follows that in verifying dates, great mistakes may be made, if attending merely to the name or numeral of the *Chakra* year. It will be seen in the following pages, that in present times the expunged years of the *Jyautistava* Style, precedes those of the *Sorriah Siddhanta* by 13 years; and that the whole of the *Chakra* or Cycle, according to the Tellinga Astronomers, whilst in reality it was 66 years in A. D. 1800 behind those of the two former authorities, yet from their manner of telling off the odd years of the Cycle, it seems to lose only 11 years in the said Christian year.

A view of the Epochs of expunged years from the beginning of the *Call yug* to A^o 5128 complete (A. D. 2025) according to the *Sorriah Siddhanta*, is given in a separate Table (XVIII, page 20), and in another (XIX, page 23) the same, according to the *Jyautistava*, from the birth of *Salivahana* (A. C. 3170, A. D. 78) down to the 2033d Christian year. It also exhibits the Difference of Epochs of the two Styles.

These Tables will suffice to rectify by inspection, any date recorded in *Vrihaspati* years only (which sometimes happens on old inscriptions, when that of the other Styles is obliterated by time), provided it be known to which Style it belongs; a circumstance which must depend on the country which gave birth to the document.





On the INDIAN CYCLE of 60 YEARS OF VAIHASPATI CHACRA. (*)

I HAVE not been able to discover the origin of the practice of reckoning time with reference to the revolutions of the Planet Jupiter, but it is no doubt very ancient; not only from there being nothing on record, but from the circumstance of its legitimate application having (if it ever did) long since fallen into disuse in the Peninsula of India, where 60 Solar years are supposed to be equal to five revolutions of the Planet, a proposition which is warranted neither by the *Surriah Siddhanta*, the *Tikas*, nor observation.—Generally, one year of Jupiter's Cycle is supposed to answer to the time during which the Planet passes through one Sign of the Zodiac.

The mean Solar Sydereal year, according to the *Surriah Siddhanta*, consists of 365° 15' 31" 31" 24' (neglecting 24 suras). Of Jupiter's revolutions there are 364220 in a *Bhaha yug*; therefore Jupiter's motion in a Solar year is $\frac{365350}{364220} = 1^{\circ} 0' 21' 6''$ exactly. Subsequent Astronomers, however, finding that this quantity deviated from the observation, have imagined a correction of 8 revolutions of the Planet in a *Maha yug*; whence we have, as 4320000 to 8 revolutions, so one Solar year of 365° 15' 31" 31" to 2° 24" the correction or *Bijah*, which is subtractive;

Therefore	-	-	-	-	-	1° 0' 21' 6" 0"
<i>Bijah</i>	-	-	-	-	-	- 2 24
Corrected motion in 1 Solar year	-	-	-	-	-	1 0 21 3 36

In order to have Jupiter's year expressed in Solar time we have, as 36° 21' 3" 36" to 365° 15' 31" 31", so 36° to 365° 2' 4' 44", 2320 Ar. the true duration of the *Chakra year*.

Such are the quantities which govern the Tables at the end, constructed for the purpose of abridging these long and tedious operations.

There are several Rules for computing the years of the *Chakra*, three of which I shall consider as being the most in use, viz. 1st. That of the *Surriah Siddhanta*; 2^d. that of the *Jyautistana*; and 3^d. that of the *Tellingas*, the latter of which is followed in the Southern parts of India.

Mr. Davis has explained in a general manner the theory of the two former, in a Memoir published in the III^d volume of the *Asiatic Researches*, but as it required much extension to reduce the respective problems to practice, I shall enter more minutely into the subject than he did.

Solar year of the
Surriah Siddhanta
365° 15' 31" 31" 24'

It's motion per-
revolution 11 0' 2' 5"

Bijah 2° 24' yrs
subtractive

Motion in 1 Solar
year is 6° 21' 3" 36"
It's year 365° 2' 4' 44"
2320 Ar. in Solar
time.

Three Rules or Styles
for the Cycle of 60
years.

(*) This Cycle has been imagined, but without foundation, to be the same as the Chaldean Seven.

According to the Surriah Siddhanta.

Precept by the Surriah Siddhanta.

"Multiply by 12 Jupiter's expired bhaganas (revolutions) and (to the product) add the Sign he is in; divide (the sum) by 60, the remainder or fraction shows his current year, counting from Vijaya" (the 27th of the Chakra inclusive) "as the first of the series." (Asiat. Researches, volume III, page 213).

How to find Jupiter's elapsed revolutions and mean Heliocentric Longitude at any given Epoch, will be shewn in another part of this collection. At present let it be understood, that it may be readily obtained by means of Table XI. At for the Bijah, Mr. Davis has shewn that 4320000 years are to 8 revolutions, as 1500 years, to 1. Hence $1500 : 1 :: x : \frac{x}{1500}$, which is the general expression of the Bijah, x representing the years expired since the commencement of the Cali yug, when the Planets were supposed to be in conjunction in the first point of the Hindu Zodiac.

EXAMPLE I.

Example by the Kalpa.

Let it be proposed to find the rank, name and beginning of the *Vrihaspati* year concurring with A. C. 4871, relatively to the commencement of the said Solar Syderal year current, or 4870 complete.

Say, as 4320000 Solar years, to 364230 revolutions of Jupiter, so 4870 to $410^{\circ} 7' 2' 37'' 0''$, the revolutions and Longitude of Ψ , at the end of the said year.

For the Bijah we have $\frac{4870}{1500} =$	.	.	.	—	0° 3' 14' 48"
Longitude uncorrected	.	.	.	—	7 2 37 0
Ψ 's mean Heliocentric Longitude corrected	.	.	.	—	6 29 21 12

For the number of Cycles expired and years current.

Rev.	410
×	12
	—
	4920
+	7
	—
	60)4927(82 Cycles.

127

Remainder 7 years, from Vijaya, the 27th year of the

Chakra inclusive, which therefore makes *Vicari* the 33d, the year current. But here it is to be remembered, that the numeral 33 is merely nominal, as will be shewn hereafter.

For the time of beginning of the said year *Vicari*, relatively to that of the concurrent Solar year 4871, say, as $2^{\circ} 30'$ in 1 month of 30 days of Jupiter's own time, so $29^{\circ} 22' 12''$ (the remaining part of the Longitude) to 11 months, 22 days (352^d), 26 Gandas, 23 palas, 19,80 castas, *calas* of *Saura* time, which shews the portion of the Planet's time in the year *Vicari* expired on the 1st Chaitram (Bengal Vaisâkha) A. C. 4871 current.

Now to have the precise date in *Solar time*, say as before (page 109), at $30^{\circ} 21' 3'' 26''$ to $365^{\circ} 15' 31'' 31''$, so $29^{\circ} 22' 12''$ to $353^{\circ} 27' 10'' 31''$ (*), the number of Solar days, daudat, &c. elapsed of *Vicari* on the 1st Chaitram 4871 of the Cali yug.

For the date of the beginning of the said *Vrikshapatti* year according to the Christian Kalendar, finding by the General Solar Table at the end of the volume, that the year Cali yugam 4870 ended on the 29th April 1769 N. S. It follows that the commencement of the year *Vicari* fell on the 21st April 1768.

Date of the beginning of the *Vrikshapatti* year according to the *Avoprem* Kalendar.

And if the Civil date according to the Hindu Solar Style be required, the process indicated in the preceding Memoir, is to be followed.

According to the Hindu Solar Kalendar.

How to compute the same by the Tables.

Let Jupiter's mean Heliocentric Longitude for the end of the same year Cali yugam 4870, be required. Then by Table XI, we have

The same by the Tables.

Epoch 4400	Drava	-	-	370 11 17 20 0
4870	Column III, 400	-	-	33 8 20 40 0
	II, 70	-	-	5 10 24 37 0
470				410 7 2 37 0
				Bijah - - - 3 14 48

For the Bijah, Table XII, page 15.

Epoch 4400				410 6 29 21 12
Drava	-	2' 58' 0"		12
Column III, 400		16 0		4920
Column II, 70		2 48	for 6"	+ 7
Bijah	-	3 14 48		60)4927(82 7 from Vijaya the 27th.
				127

Therefore *Vicari* the year current - - - 7

For the Solar time due to	20 22 12	By Table XIII, page 10.
Column I, 20'	- 240 41 23	0,4880
0	- 108 18 37	25,2500
II, 20'	- 4 0 41	23,1691
2	- 24 4	8,3169
III, 10'	- 2 0	20,6929
2	- 24	4,1380

Solar time expired of *Vicari* - $353^{\circ} 27' 10'' 31'' 0540$

The same (neglecting the decimals) as in the preceding Rule.

N. B.—The Table XLIII (page 56 of the Tables) of *Vavilala Cuchinna*, give Ψ 's motion in 30 days $2^{\circ} 29' 34'' 24''$, which for one Solar year amount to $1^{\circ} 0' 21' 3'' 26''$, differing only from the

(*) For Ψ 's year expressed in Solar time, say :

At $20^{\circ} 21' 3'' 26''$	3850 154 31p 31c 11	30°	3814 24 4p 44c 27223
6535916"	18802591c	6400000"	11983443,23273

The length of Jupiter's year, which governs Table XIII, page 10.

quantity given by the Sarriah Siddhanta, (corrected by the Bijah) by 10^6 , answering to 2 pal.
0,3448 cent. in Solar time.

RULE.

The same according to the Jyautistava (a book on Astrology.)

Jyautistava Rule.

This Rule expounds the *last expired*, instead of the current year of the Chakra.

Precept.

“The Saca years note down in two places. Multiply (one of the numbers) by 22. Add (to the product) 1201. Divide (the sum) by 1875. The quotient (its integers) add to the 2d number noted down, and divide (the sum) by 80. The remainder or fraction will shew the last year expired, counting from Prabhava (inclusive) as the first of the Cycle. The fraction, if any left by the divisor 1875, may be reduced to months, days, &c. expired of the current year.” (Arist. Res. vol. III, p. 214).

1st result in Saura time.

The Jyautistava uses the Solar year according to the Aris Siddhanta 365d. 15 21 15.

Here it is proper to observe, that the fraction of the first term when amounting to unit represents one Chakra year of 360 days, which the Hindus call *Saura time*; therefore, in order to have the true Solar time elapsed it will be, as 360° Saura to 365° 13' 31" 15" (the duration of the Solar year according to the Aris Siddhanta), so is the number of Saura days elicited by the fraction reduced into time, to the corresponding number of days, &c. in Solar Syderal time.

EXAMPLE II.

Example by the Rule.

Let the year of the Cali yug 4870, or (4870—3179, 1691 Saca complete, be proposed: wanted the circumstances of the concurrent Vrihaspati year.

By the foregoing precept we have 1691.

$$\frac{1691 \times 22 + 1201}{1875} = 22 \frac{877}{1875} \text{ and } \frac{1691 \times 22}{80} = 48 \frac{31}{40}$$

The first fraction when reduced into time ($\frac{877}{1875}$), shows that 5m 17d 36^h 57^m 6 had expired of the year indicated by the 2d fraction ($\frac{31}{40}$), i. e. *Picari*, on the 1st Chaitram of the year 1692 Saca current, in *Saura time*; to reduce which into *Solar time* we have, as 360° : 365° 13' 31" 15" :: 5m 17d (167d) 36^h 57^m 6 : 170° 3d 51^m 51^s 7^c cent. And as the Solar year began on the 9th April A. D. 1769 (*), it follows that (according to this Rule) the Chakra year *Sareari* (the 34th and current one) began on the 21st October A. D. 1768.

In comparing hereafter the results of the two foregoing Rules, we shall thus find them expressed in the same species of time, which Mr. Davis has omitted to consider.

How to compute the same by the Tables.

The fraction of the first member of the expression will be expounded as follows, by Table XIV, page 18.

The same by the Tables.

	Numerator,	p. den. p.
Column III, for 1690	-	123 30 0
II, 70	-	19 26 84
I, 3	-	24 23,6
for 174 364 ^h 57 ^m 6		in Saura time 167 30 57,0

(*) Solar General Table at you end,

To reduce which to Solar time, by Table XVI, page 18:

Column I, 100	-	a. d. p.	101 27 23,68200
II, 40	-	60 51 25,00020	
7	-	7 0 9,10774	
20	-	30 26,20341	
6	-	0 5,35308	
III, 50	-	50,70037	
7	-	7,10224	
0,5	-	0,60875	
		a. d. p. can.	
Expired in Solar time	=	170 3 51,51240 or 170 3 51,744	

The same result as by the Rule.

ILLUSTRATION.

The multiplier 22, and the divisor 1875, are explained in the following manner by Mr. Davis. According to the Astronomical treatise called the *Aria Siddhanta*, there are 364224 mean revolutions of Jupiter in a *Maha yug* (instead of 364230 assigned by the *Sarriak Siddhanta*, the Solar years of the latter being 3650 134 21p 31e and of the former 3650 134 31p 13e); therefore 364224 rev. contain 4370688 of the Planet's *own years*, which exceed the Solar years in a *Maha yug* by 506887, and 4320000 and 50688 being reduced to their lowest terms are 1875 and 22; therefore in 1875 Solar years, there is an excess of 22 *Vrihaspati* years.

The additive number (1st member) 4291, by the Hindu Astronomers called *Ukapa*, adjusts the computation to the commencement of the *Ära Sara*, or the birth of *Salivahana*, which occurred when 3178 years of the *Call yug* had expired. In order, therefore, to have the time elapsed of the *Vrihaspati* account at that Epoch, if we use the above formula it will be $\frac{0 \times 22 + 4291}{1875} = 2 \frac{541}{1875}$ and $\frac{0 + 2}{60} = 0 \frac{0}{60} = \frac{4291}{1875} = 2 \frac{541}{1875} = 2 \frac{541}{1875} = 2 \frac{541}{1875}$ in *Saura* time, and 2s 1053 233m 21p 29s,5872 (Table XVI) of *mean Solar Sydereal time*, which had already expired of the 54th Cycle when that *Ära* began. (*)

(*) In order to compare this Epoch as expanded by the two Rules, we shall compute the same by that of the *Sarriak Siddhanta*, as follows:

Epoch 4400		Table XI, Column III, 1000	a. d. p.	1000 0 0
3119		310	10 10 10 00	0
1221		II, 20	1 18 7 0	0
		I, 1	0 1 0 21 0	0
		1221	109 11 9 29 6	0
		Days	570 11 17 20 0	0
			555 0 7 36 24	0
		Bijah	2 7 0 38 0	0
			555 0 5 49 24 24	0
			12	0
			536	0
			2680	0
			1	0
			60,8217 (32 1/2)	0
			217	0
			37	0

Remainder

Illustration.

According to the *Aria Siddhanta* 364224 rev. of $\frac{1}{2}$ in a *Maha yug*.

Ukapa, an Equation which adjusts a computation to a particular period.

Epoch of *Vrihaspati* reduced to the *Ära* of *Salivahana*.

RULE.

According to the Tellinga Astronomers.

Rule according to the Tellingas.

This Rule gives the last expired year from the beginning of the Cali yug : it takes no notice of the commencement of the Vrihaspati year, which it identifies with that of the *Chandra mano*, or Luni-solar year current.

Precept.

" Divide the expired years of the Cali yug by 60, the quotient will give the number of Cycles expired, and the first year of the remainder will answer to *Pramathi* the 13th year of the Chakra. Count the number of units of the said remainder from the said *Pramathi* (inclusive), you have the year of the Chakra last expired, and that which follows is the current one."

EXAMPLE.

Rule.

Let it be proposed to find the rank and name of the Vrihaspati year concurrent with A. C. 4870 complete, or 4871 current.

By the above precept we have

$$\begin{array}{r} 60 \overline{) 4870} \quad 81 \frac{10}{70} \\ \underline{4800} \\ 70 \\ \underline{70} \\ 0 \end{array}$$

and the numerator of this fraction 10 being told off from *Pramathi* inclusive, gives *Sarsauhari* the 21d, as the last expired, and *Firedhi* the 22d, as the current year sought; the integers shewing that 81 Cycles have elapsed since the beginning of the Cali yug, and therefore that the 22d is the current one.

Comparison of the three results.

Comparison of the three results.

In order to compare the number of Cycles and years expired according to each Rule, we are not to refer to the numerals of the Chakra years, as arranged in the series given in modern Astronomical books; because each authority begins from a different point of the Chakra for counting the odd years after division by 60; without any reference to the revolutions of the Planet at any given Epoch, which nevertheless are the true scale by which such time should be measured;

which remainder 37, counted from *Vijaya* the 27th of the Chakra, falls on *Sada* the 3d year current of the 54th Cycle complete; and for the time due to 5° 45' 44" 24" Longitude of the Planet on the 1st day of the Solar year Cali yugam 2180, we have

Table XIII, Column I.	5+	-	-	-	-	6.	5.	4.	3.
II, 40	-	-	-	-	-	60	10	10	47,3722
III, 40*	-	-	-	-	-	8	1	22	40,3163
IV, 40*	-	-	-	-	-	1	48	18	37,4219
	-	-	-	-	-	-	8	1	22,7710
	-	-	-	-	-	-	-	48	2,2773
	-	-	-	-	-	-	-	4	6,6997
	-	-	-	-	-	-	-	-	48,1380

Solar time expired at the beginning of the <i>Shra Saka</i>	54	55	56	57	58	59	60	61	62
	2 years	70	8	58	30,5863				
		100	22	21	29,9512				
Difference	33	14	24	55,9067					

The *Sorriah Siddhanta*, from counting the odd years from Vijaya (the 27th) as one or *Nandana* (25th) as zero, considers manifestly that Jupiter and the Sun were once in the first point of Mesha at the beginning of *Vijaya* and of the *Call* yug. Thus in Example 1, page 200, we found that at the end of the Solar year of the *Call* yug 4870, the current *Chakra* year was *Ficra* (333) and the last expired *Vilamea* (333) of the 22d Cycle current. But the revolutions and Longitude of Jupiter at that instant were $410^{\circ} 6' 29' 22'' 12''$, which gave $82^{\circ} 6'$ complete, the 9 years to be counted from *Nandana* as zero, and therefore *Vilamea* the 6th in the series marks the true time elapsed, and not *Vilamea* the 33d, as numbered in the modern list. The former is consequently that to be used for comparison.

By the *Sorriah Siddhanta*.

29. The *Jyautistava* rule which computes in Solar years, but with reference to Jupiter's motion, takes the series to be numbered as in the list referred to, viz. *Calaga* the 60th year of the *Chakra* as zero and *Prabhava* as one. But in so doing it uses a *Libra* of 27 years earlier than the *Sorriah Siddhanta*, which adapts the numerator of the fraction of the second number of its rule, to the year elicited by the latter.

By the *Jyautistava*.

Thus in Example 2, page 202, the cycles and years expired in the year *Call* yug 4870 complete from the birth of *Sallabhana* are, 28 cycles, 33 years, to which adding 54 years, we have for the cycles and years expired since the beginning of the *Call* yug $82^{\circ} 33'$, if from this we subtract 27

— 27
we have $82^{\circ} 6'$, the same numbers as those

elicited by the rule of the *Sorriah Siddhanta* when taking *Vijaya* as 1 of the series.

30. With respect to the *Tellingas*, as their account is entirely Solar without any reference to the motion of Jupiter, the difference is exactly that arising out of the Solar and *Prakaspiti* years expired. Hence if we divide the year of the *Call* yug 4870 by 60,

According to the *Tellingas*.

we have for quotient	.	.	$81^{\circ} 10'$
which subtracted from	.	.	$82^{\circ} 6'$
leaves	.	.	$0^{\circ} 56'$

which 56 years mark the number of expunged or *Calaga* years which have occurred since the beginning of the *Call* yug, as will be shown from other principles.

From the foregoing considerations it follows, that the relative measure of time of the respective accounts is not to be deduced from the numerals of the years of the *Chakra* according to our list, but from the actual revolutions of the Planet as expounded at page 200, Example 1, the former giving the following erroneous results, viz.

From the <i>Sorriah Siddhanta</i>	.	.	$82^{\circ} 33'$	} + $0^{\circ} 1'$ — $1^{\circ} 10'$ or 70 years, which on
<i>Jyautistava</i>	.	.	$82^{\circ} 33'$	
<i>Tellingas</i>	.	.	$81^{\circ} 22'$	

a first view might be supposed to be the correct ones.

To the Solar year 4871, add 86 years, the sum will be 4957 complete.

To Ψ 's Longitude above found	-	-	-	-	417	7	29	54	25	12
Add for 86 Solar years (Table XI)	-	-	-	-	7	3	0	11	9	36
Ψ 's Longitude at the end of 4957	-	-	-	-	417	10	29	54	25	12
				add				5	34	48

You have 11 signs without a remainder - 417 11 0 0 0 0

But by Table XIII, $5^{\circ} 34' 43''$ answer to $15 7^{\circ} 2' 8''$, 8009, therefore the expunged year was due in the Solar year 4958 current, when $15 7^{\circ} 2' 8''$ of the month Chaitram had expired.

Hence, as the Ed Cshaya was due in 4958 $\begin{smallmatrix} y. & o. & d. & p. & c. \\ 1 & 7 & 2 & 8 & 009 \end{smallmatrix}$
(365 15 31 31)

And the 1st in - - - 4957 $\begin{smallmatrix} 365 & 22 & 4 & 29 & 8009 \\ 4872 & 3 & 21 & 27 & 26,4027 \end{smallmatrix}$

55 363 1 13 13,3982, which reduced into Jupiter's

time by Table XVII, page 18, will be

Solar.	Of Jupiter.	
Column Ψ , $\begin{smallmatrix} y. \\ 80 \\ 5 \end{smallmatrix}$	$\begin{smallmatrix} y. & o. & d. & p. & c. \\ 80 & 337 & 55 & 42 & 21,2416 \\ 5 & 21 & 7 & 13 & 53,8274 \\ + & 363 & 1 & 13 & 13,3982 \end{smallmatrix}$	
	$\begin{smallmatrix} 2) & 722 & 4 & 0 & 28,4672 \\ (361 & 2 & 4 & 44,2336 \end{smallmatrix}$	
One year of Jupiter, page 199	-	-
Sum of Ψ 's years	87	0 0 0 0

Period of the Cshaya
85y 363d 1d 13p
13c,3982.

Therefore 85y 363d 1^h 13^m 13^p,3982 &c. of Solar time, answer precisely to 87 years of Jupiter's, and the former quantity marks in Solar time the period when one of Jupiter's years is to be expunged. This is the quantity which governs Table XVIII, page 20, where the Epoch of every Cshaya due since the beginning of the Cali yug is exhibited. (*)

It need hardly be hinted that the Equation $16^{\circ} 44' 34''$ added to the process for the year 4871, and $5^{\circ} 34' 43''$ for the year 4957, when added together amount to $11^{\circ} 9' 36''$, the common excess of Ψ 's Longitude over 3 signs in 86 Solar years, as has been shown at page 205.

In the preceding Examples, as the degrees of Ψ 's Longitude did not amount to a whole sign when the Solar year began, the Cshaya was due in the beginning of the following Solar year: but if we continue as before for the next period, viz.

Revolution and Longitude A. C.	4957	-	-	417	10	29	54	25	12
	86	-	-	7	3	0	11	9	36
	5043	=	-	425	2	0	5	34	48

(*) The mean difference used in that Table is 85y 363 1 13 13,3980; differing from the above value

As the minutes, seconds and thirds exceed a complete sign (whereas the same quantity was wanting from it in the preceding Example), it shews that the *Cakya* was done before the end of the Solar year 5043; and that the interval of time wanting to reach it, is that which answers to $5^{\circ} 34' 49''$, viz. $12749982,8006$; so that the precise Solar Epoch is A. C. 5043y 354, 82 22p 22s, 1901.

By help of these observations, the construction and use of the Tables from XI to XVIII may be easily understood and demonstrated.

I shall now turn to the consideration of the periods of the expunged years of the Chacra according to the *Jyautistava* account, the theory of which is rather more intricate than that of the foregoing style.

Of the expunged year according to the Rule of the Jyautistava.

Periods of Jupiter according to the *Aria Siddhanta*. 4370088 revolutions in a Maha yug.

We have already observed (page 203) that the *Jyautistava* follows the periods of the *Aria Siddhanta*, which assigns 4370088 revolutions of Jupiter in a Maha yug, or 4320000 mean Solar Syderal years, the duration of each being $365^{\circ} 15^d 31p, 25$. It appears, however, that the author of the rule has occasionally warped these quantities, so as to make them fit his system, which represents the duration of one year of \mathcal{V} to be equal to $\frac{355}{337}^{\circ}$, and which fraction serves to express the different circumstances of the Problem.

Jupiter's year 355 49 29,95255 in Saura, and 361 1 21,55594 in mean Solar Syderal time, for which see Table XVI, page 18.

From what precedes, Jupiter's year is $\frac{3379555}{1000000} = 0y 11^m 25^s 49^d 29p, 95255$, &c. or $355^{\circ} 49^d 29p, 95$, &c. expressed in Saura time of 360 days in the year.

In order to have the same expressed in Solar Syderal time, say, as $360^{\circ} : 355^{\circ} 15^d 31p, 25$, so is $355 49 29,95255$, &c. to $361^{\circ} 1^d 21p, 6496$, which is the duration of the *Vrihaspati* year according to the *Aria Siddhanta*.

It will be shewn however, presently, that the *Jyautistava* takes the *Vrihaspati* year nearer to $355^{\circ} 49^d 30p, 418604$, &c. of Saura time, the difference being $0p, 466050$, and that in one of its Equations, it retrenches $2p, 03239$, &c. from the duration of the same, for no other purpose, than I could discover, than to fit the theory to the rule.

Of the occasion of the Cakya year.

Of the occasion of the *Cakya*.

Let the circumstances of the *Vrihaspati* year concurring with A. C. 4858 or 1679 Sacs, be computed; there will be $\frac{1679 \times 22 + 4891}{1679} = 21 \frac{1854}{1679}$ and $\frac{1679 + 51}{60} = 28 \frac{20}{60}$.

Use Table XIV, page 18.

The 1st term reduced into Saura time will give 21 years, $11^m 25^s 58^d, 4$, by which quantity (at that period) the *Vrihaspati* had advanced before the Solar time, and the last member of the rule shews that 28 cycles and 20 years had elapsed since the Epoch. *Vijaya* was therefore, the last expired year, being the 20th of the Chacra, and *Sarrajit* the 21st, the current one, of which the above number of Saura months and days had expired on the 1st Chaitram (Bengal Vaisâkha), or the beginning of the Solar year 1680.

Compute now for the ensuing year Call yug 4259, or 1680 Saca.

$$\frac{1680 \times 22 + 4291}{1875} = 22 \frac{1}{1875} \text{ and } \frac{1680 + 22}{60} = 28 \frac{22}{60}.$$

Here it will be perceived, that the first member has passed from $21 \frac{11 \frac{1}{2}}{11 \frac{1}{2}}$ to $22 \frac{1}{1875}$ and the second from $28 \frac{1}{2}$ to $28 \frac{22}{60}$, the numerators of the last fractions 20 and 22 shewing that in the space of one Solar year, one of the Chakra is to be passed over: Hence, on the beginning of the Solar year 1681 the last *Vrihaspati* year expired is not *Sarvadhari* the 22d, but *Virodhi* the 23d.

Again, as in the computation for 1679 the fraction of the 1st member was $\frac{11 \frac{1}{2}}{11 \frac{1}{2}}$, which answered to $11^h 25^m 58^s.4$ Saura time expired, there wanted only $4^h 14^m 56^s$ for reaching the commencement of the next Chakra year *Sarvadhari*.

But in the rule for 1680, the fraction of the 1st term was $\frac{1}{1875}$ answering to $11^h 31^m.2$ Saura time already elapsed on the 1st Chaitram since the year *Sarvadhari* had ended. Hence the whole of the Chakra year *Sarvadhari* was expended during the Saca year 1680 current, on which account (like the Lunar Tithis which begin and end in the same Solar day in the Chandra Mana) that year is expunged out of the Kalendar.

Cause of the Chakra.

In order to account for that circumstance, we shall consider generally the period of recurrence of the expunged year.

Illustration.

For the periods of the Chakra.

It is to be observed that, the only variable quantity of the first member of the rule is the numeral of the Solar year for which the time is computed, and as that quantity is always multiplied by 22, it follows that the first term increases yearly by $\frac{22}{1875}$, and if we raise this quantity by 86, the first term will increase by $(86 \times \frac{22}{1875})$ $1y \frac{11 \frac{1}{2}}{11 \frac{1}{2}}$ in 86 years.

Thus if we compute for the years Saca 572 and 658, we shall have for 86 Solar years

$$1st. \frac{572 \times 22 + 4291}{1875} = 9 \frac{0}{1875} \text{ and } \frac{572 + 9}{60} = 9 \frac{41}{60}.$$

$$2d. \frac{658 \times 22 + 4291}{1875} = 10 \frac{17}{1875} \text{ and } \frac{658 + 10}{60} = 11 \frac{8}{60}.$$

$$2d. (11^h 8^s \text{ or } 10^h 68^s + \frac{11 \frac{1}{2}}{11 \frac{1}{2}})$$

$$1st. 9^h 41^m \frac{17}{1875}$$

$$\text{Difference } 1 \ 27 \ \frac{11 \frac{1}{2}}{11 \frac{1}{2}} \text{ or } 87 \frac{11 \frac{1}{2}}{11 \frac{1}{2}}.$$

Therefore 86 Solar years answer to $87 \frac{11 \frac{1}{2}}{11 \frac{1}{2}}$ of the rule, and subtracting the fraction from both, we have $85 \frac{11 \frac{1}{2}}{11 \frac{1}{2}}$ and 87 years, which however, must not be taken to be exactly 87 years of the Planet, as shall be shewn presently.

The fraction $\frac{11 \frac{1}{2}}{11 \frac{1}{2}}$ being converted into time (Table XIV, page 16) will answer, together with the years, to $85y \ 356d \ 44d \ 9p.6$, and this is one of the periods which will serve for finding the Epoch of any other expunged year, that of any one being given.

In period, $85 \frac{11 \frac{1}{2}}{11 \frac{1}{2}}$
or $85y \ 356d \ 44d \ 9p.6$
or $85 \ 391 \ 58 \ 49.208$
in Solar time.

The other period requisite for the general resolution of the problem, is the time due to 86 of

2d period, 85 $\frac{5}{1273}$
or 85y On 57d 59p
i. e. 85y On 56d
13p, 45332 in Solar
time.

Jupiter's years, which being one less than the preceding, may be obtained by subtracting from the integer the annual increase or $\frac{1875 - 22}{1875} = \frac{1853}{1875}$. This quantity subtracted from the first period, viz. $85 \frac{1858 - 1853}{1875} = 85 \frac{5}{1273}$, will give the period sought; and the fraction $\frac{5}{1273}$ answering to 57° 38', will be in *Saura time* 85y On 57d 36p precisely according to the rule. (*)

Resolution of the Epochs.

By means of the two periods above determined, the recurrence of the expunged year may be found with precision according to the *Jyautistava* account.

EXAMPLE.

Let the given Epoch be that calculated at page 202, by means of the year *Saca* 572, where the fraction of the 1st member being zero, shows that the commencement of the Solar and *Vikram* years were simultaneous. We shall have the following series.

	y.		y.		y.	y.	d.	d.	p.
						572	0	0	0
572 + {	85	$\frac{1858}{1875} = 572 + 85 + \frac{1858}{1875}$	$= 657 \frac{1858}{1875} = 657$	$\frac{1858}{1875}$	$= 657$	356	41	9,6	
	2×85	$\frac{5}{1875} = 572 + 170 + \frac{1858 + 5}{1875}$	$= 742 \frac{1863}{1875} = 742$	$\frac{1863}{1875}$	$= 742$	357	41	45,6	
	$3 \times 85 + 2 \times \frac{5}{1875}$	$= 572 + 255 + \frac{1858 + 10}{1875}$	$= 827 \frac{1868}{1875} = 827$	$\frac{1868}{1875}$	$= 827$	358	39	21,6	
	$4 \times 85 + 3 \times \frac{5}{1875}$	$= 572 + 340 + \frac{1858 + 15}{1875}$	$= 912 \frac{1873}{1875} = 912$	$\frac{1873}{1875}$	$= 912$	359	36	37,6	

Saura time,

where the 1st period (of 87 Chakra years) has first been added to the Epoch A. S. 572, and then the 2d (of 80 C. years) added in succession so long as the fraction does not exceed unity or $\frac{1}{1273}$.

In the present case the fraction amounting in A. S. 912, to $\frac{1873}{1875}$ cannot evidently be increased by $\frac{5}{1273}$ without exceeding unity, as was the case at the preceding periods: Hence, the last resolution A. S. 912 $\frac{1873}{1875}$ becomes a new Epoch, to which the first equation is again to be applied; the remainder of the fraction to unity being $\frac{1}{1273}$.

(*) That these periods of Jupiter's revolutions are only *Jeue*, relatively to the Rule, will appear from multiplying his year according to the *Aria Siddhanta* (above determined) by 86 and 87.

$3350.496 \text{ } 29p, 93255 \times \frac{86}{87} = 85y \text{ On } 56d \text{ } 59p, 91910, \&c. \left. \vphantom{\frac{86}{87}} \right\} \text{Saura time.}$
 $\frac{87}{87} = 89 \text{ } 350 \text{ } 40 \text{ } 25p, 91165, \&c.$

N. B.—In the following Examples I have preserved the *Saura* in preference to the Solar time, because the fraction is easily reducible to it by means of Table XIV.

For the succeeding Epochs we have, therefore,

r.	Epoch	r.	p.	d.	p.
	912	$\frac{1875}{1875} =$	912	359	35 57,6
85 +	$\frac{1858+1873}{1875} =$	998	$\frac{1858}{1875} =$	998	356 21 7,2
170 +	$\frac{1858+5+1873}{1875} =$	1063	$\frac{1861}{1875} =$	1063	357 18 43,2
255 +	$\frac{1858+10+1873}{1875} =$	1168	$\frac{1865}{1875} =$	1168	358 10 19,2
340 +	$\frac{1858+15+1873}{1875} =$	1258	$\frac{1871}{1875} =$	1253	359 13 55,2

Saura time,

where the period for the year Saca 998 has been found by adding $912 \frac{1}{1875}$ to $85 \frac{1}{1875}$, the 1st equation (page 210) = $912 + 85 + 1 + \frac{1}{1875} = 998 \frac{1}{1875}$, and the subsequent ones by adding $85 \frac{1}{1875}$ for each interval to $912 \frac{1}{1875}$.

Here again the last fraction warns us that the series can be carried no further, the remainder to unity being $\frac{1}{1875}$ and the periodical increase being $\frac{1}{1875}$. Therefore a new Epoch must again be determined by adding $85 \frac{1}{1875}$ to $1258 \frac{1}{1875}$, as we have done in the preceding case.

And thus the periods, when a Chacra year is to be expunged, may be calculated ad infinitum without the least error.

N. B.—The series of Epochs the difference of which is 85 Chacra years, and which in the two preceding Examples extend only to four, may in some cases amount to five; which circumstance depends on the fraction approaching sooner or later to unity. Thus if the foregoing periods be carried on, by the same rule, the 4th period from the last Epoch will be $1504 \frac{1}{1875}$ and the fraction admitting of a farther increase by $\frac{1}{1875}$ without reaching unity, the next will be $1679 \frac{1}{1875}$, wanting only $\frac{1}{1875}$ from it, and therefore occasioning a new Epoch.

General Observations.

As it has been customary from time immemorial in Southern India, to annex the name of the Vrihaspati year to all dates expressed in Luni-solar time, and as the Jyautistava rule which is followed in some countries gives Epochs for expunged years greatly different from those of the Surriah Siddhanta, I have taken some pains to investigate the mechanical operation of the rule of the former with a view to establish the difference of their Epochs, and this will be found in Table XIX, p. 23, where the Epoch of every expunged year according to the two Styles, has been computed since the Epoch of Salivahana, beyond which the Jyautistava account does not ascend.

Coincidence of the
Siddhanta and Jy-
autistava Chacra
years.

Table XIX, page 23, shows that whereas in the year of the Cali yug 3239, or Saca 60, the Jyautistava account placed the Cshaya two years later than the Surriah Siddhanta, in the present time, on the contrary (1679 Saca) it falls 13 years earlier.

For the years of the Chacra according to the Tellingus relatively to those of the Sastra's style, see page 205, where it is shown that in the 4870th of the Cali yug the former was slower by 55

Coincidence of the
Siddhanta and Tel-
lingus Chacra years.

years, the number of expunged years since the commencement of the yug, an equation unknown to the Tellingus.

On the concurrence of the Vrihaspati and Christian years.

Concurrence of the
Vrihaspati and
Christian years.

Lastly, with regard to the concurrence of the Christian years with those of the Chakra, although we have been compelled for the sake of arrangement to annex the numeral of the Christian year which coincides most with the Hindu Solar years, to the beginning of which the time elapsed of the Vrihaspati year is referred, yet it is sufficiently obvious from what has been stated in the first part of this article, that it may be very near ending when the former is about to commence; in which case there would be so much of the *Vrihaspati* year elapsed on the Christian date on which the Hindu Solar year begins (which for a long time past has been in the month of March, *Julian style*), that the said *Chakra* year would more properly be coupled with the preceding Christian year than the former.

Thus on the 1st Chaitram of the Solar year 4871 from the *Cali* yug current, there remained, according to the rule of the *Suryah Siddhanta*, only 7 days to run of the *Chakra* year *Vicari* (361° 2'—363° 17')—but the said Solar year began on the 2d April 1769; therefore the greatest part of *Vicari* from its beginning elapsed in A. D. 1768. But the custom has always been to couple the name of the *Vrihaspati* year, at whatever period it may begin, with that of the Solar years from whose commencement that of the former is deduced. Now as A. D. 1769 is considered mainly to coincide with A. Cal. 4871 current (4870 ending in the said Christian year); so is *Vicari*, the *Chakra* year under consideration, coupled with 1769; and thus Mr. Davis has found that the year of Christ 1784 corresponded with *Ananda* and *Rasahara* the 48th and 49th years of the *Chakra* (*); but this double notation would be attended with so much inconveniency, that I have seen it used no where.

On the Vrihaspati Cycle of twelve years.

On the Vrihaspati
Cycle of 12 years.

In the Cycle of sixty are contained 5 Cycles of twelve years, each supposed equal to one year of the Planet. I only mention this Cycle because I found it mentioned in some books, but I know of no nation or tribe that reckons time after that account.

The names of the five Cycles, or Yugas, are as follows :

Names.		Presided by
1. Sumvatsara	- .	Agni.
2. Parivatsara	- .	Arca.
3. Idavatsara	- .	Chandra.
4. Anuvatsara	- .	Brahma.
5. Udvatsara	- .	Siva.

(*) Asiatic Researches, Vol. III, p. 215.

The name of each year is determined from the *Nacshatra* in which *Vaihaspati* rises and sets heliacally; and they follow in the order of the Lunar months.

The years beginning with the month *Cartic* commences with the *Nacshatra Crítica*, and to each year there appertains two *Nacshatras*, except the 5th, 11th, and 12th years, to each of which belongs three *Nacshatras*. These are arranged in the following order :

	Months beginning years.	<i>Nacshatras</i> .		Months beginning years.	<i>Nacshatras</i> .
1	<i>Cartic</i>	<i>Crítica</i> , <i>Robini</i>	7	<i>Vaisākhā</i>	<i>Vishā'ha</i> , <i>Amrādhā</i>
2	<i>Agrahayan</i>	<i>Mrigasiras</i> , <i>A'rdrā</i>	8	<i>Jyāishā</i>	<i>Jyāishā</i> , <i>Mula</i>
3	<i>Pauṣhā</i>	<i>Punarvasu</i> , <i>Pauṣhā</i>	9	<i>Āshar</i>	<i>P. A'shād'hā</i> , <i>U. A'shād'hā</i>
4	<i>Māgha</i>	<i>Aślehā</i> , <i>Maghā</i>	10	<i>Śrāvna</i>	<i>Śrāvna</i> , <i>Dhūlsh'itā</i>
5	<i>Pha'lgunā</i>	{ <i>P. Pha'lgunī</i> , <i>U. Pha'lgunī</i> , and <i>Īṣāṭā</i>	11	<i>Bhādrapada</i>	{ <i>Satabhishā</i> , <i>P. Bhādrapadā</i> , U. <i>Bhādrapadā</i>
6	<i>Chaitra</i>	<i>Chitra</i> , <i>Swātī</i>	12	<i>Āṣvina</i>	<i>Revatī</i> , <i>Nāṣini</i> , <i>Īṣṭāni</i>

It may be remarked that in the foregoing arrangement *Cartic* is placed the first in the Cycle of 12. It may therefore be inferred, that there was a time when the Hindu Solar year, as well as the *Vaihaspati* Cycle of 12, began with the Sun's entrance in, or near the *Nacshatra Crítica*.

It follows also from this, that the first year of the Cycle of 60, begins in the Lunar month *Cartic*. But the Southern Indians, if they ever did, have long since ceased to attend to the months of the *Chakra* year.

The Tables, from the Xth (page 15) to the XIXth (page 23 of the Tables) were constructed for the purpose of abridging all the operations disclosed in the preceding pages: which, independently of their being very tedious from the constant reduction of one sort of time to another, or degrees into time, expose the computer to frequent mistakes. It is to be remembered that the Tables which refer to the *Saurish Siddhanta* take the Solar year to be 365° 15' 31" 31", 24 and those which refer to the *Arīa Siddhanta* 365° 15' 31" 15".—And furthermore, that the duration of Jupiter's year according to the former is 361° 2' 4' 44", 2 &c. and to the latter 361° 1' 21" 32", 1 &c. in mean Solar Syderal time, as has been shown in the course of this Memoir.

There will be found annexed to Table XVIII (page 20 and following) a variety of Examples of the application of all the rest, which supersedes the necessity of adding any thing here on the subject of these Tables. (*)

POSTSCRIPT.

From the preceding investigation we derive a Rule, which will be found very convenient for finding the *Chakra* year answering to any proposed Christian or Hindu Solar year.

(*) The names and numbers of the years of the *Chakra* will be found in the General Solar Table at the end of the volume.

Tables for computing the year of the *Chakra*.

PRECEPT.

Short Rule for obtaining the Vrhaspati year, and its rank in the Cycle of 60.

- " If the Christian year be proposed, find the corresponding one of the Cali yug by adding
 " 3101 thereto, the sum will be the last year expired of the same.
 " Divide the expired years of the Cali yug by 86; add the quotient to the dividend; divide
 " again the sum by 60, the quotient will give the number of Cycles expired, and to the remainder,
 " If the proposed year be less than 31 from the last expunged year of the Chakra (found in Table
 " XVIII), add 23, and if it falls in the 35 remaining years of the Cycle of 86, add 27, and the
 " sum will be the numeral of the year current of the Chakra.

Precept.

EXAMPLE 1.

Let A. D. 1600, answering to A. C. 4701 complete, be proposed.

Examples.

By Table XVIII we find that the last expunged year fell on A. D. 1598
 1600

Year of the Cycle of 86 years	-	-	2
10			20
Then - 86)4701(54			4701
401			54
<hr/>			<hr/>
67			60)4755(79
			555
			<hr/>
			15
			23
			<hr/>
			43 Sumya.

Here we have added 25, because the proposed year was the second of the Cycle of 86 years.

EXAMPLE 2.

Let A. D. 1824, answering to the 4925th year of the Cali yug complete, be proposed.

By the Table XVIII the last expunged year of the Chakra fell on A. D. 1770
 1824

Year of the Cycle of 86 years	-	-	54
10			20
86)4925(57			4925
625			57
<hr/>			<hr/>
23			60)4983(83
			162
			<hr/>
			2
			27
			<hr/>
			29 Manmatha.

Here we added 27, because the proposed year exceeded the 31st of the Cycle of 86 years.

EXAMPLE 3.

Let A. D. O, answering to the 3101st of the Cali yug complete, be proposed.

By Table XVIII the last expunged year of the Chacra fall on A. A. C. 36, which marks the rank of the proposed year in the Cycle of 86 years.

$$\begin{array}{r} 19 \\ 86 \overline{) 3101 (36} \\ 621 \\ \hline 5 \end{array}$$

$$\begin{array}{r} 29 \\ 3101 \\ 56 \\ \hline 60 \overline{) 3137 (52} \\ 137 \\ \hline 17 \\ 27 \\ \hline 44 \text{ Sadharma.} \end{array}$$

Here again we added only 27, because the year proposed was the 36th of the Cycle of 86 years, exceeding 31.

The reason of this operation may be explained as follows :

As the parts or fractions of years are neglected in the short Rule, the expunged years resulting from the same do not coincide with those of the Sastra rule; although both be governed by the Cycle of 86 years.

For instance, let the Christian year 1800 answering to 4901 of the Cali yug complete; the remainder 85, after division by 86, shews that the quotient 56 will increase by one on the next Solar year; and therefore, that a Chacra year will be expunged.

But by Table XVIII we find that the last expunged year of the Chacra according to the Sastra, falls on A. D.

$$\begin{array}{r} 1770 \\ 1801 \\ \hline 31 \end{array}$$

that is to say, 31 years before.

So that until then the results by the Sastra, preceded that of the short Rules by one year.

$$\begin{array}{r} 86 \overline{) 4902 (57} \\ 602 \\ \hline 0 \end{array}$$

$$\begin{array}{r} 4902 \\ 57 \\ \hline 60 \overline{) 4959 (82} \\ 159 \\ \hline 39 \\ 27 \\ \hline 6 \end{array}$$

But as in 1801, or 4902 of the Cali yug complete, the quotient after division by 86, increased by one, and as there was zero for remainder; it follows that the remainder after division by 60, increased by two; and therefore, one year of the Chacra must be expunged; that is, the numeral in the series will be increased by one; so that from the said year, to the end of the Cycle of 86 years (55) the results of both Rules will agree.

Having thus found the manner of expounding quickly the year of the Chakra, from that of the Cali yug according to the precepts of the Sarriah Siddhanta, we may easily deduce that which is elicited by the Jyotistava rule by a comparison of Tables XVIII and XIX.

END OF THE THIRD MEMOIR.

FOURTH MEMOIR.

—•—
ON THE

LUNAR YEAR

OF THE

MAHOMMEDANS.

Written in A. D. 1814 ; Revised in 1823.

1871

1872

1873

1874

1875

1876

1877

1878

1879

1880

1881

1882

1883

1884

1885

1886

1887

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1892

1893

1894

1895

1896

1897

1898

1899

MEMOIR

On the Lunar year of the Mahomedans and on the Era called Hejira.

ON a subject so fully explored as that of the Lunar year used throughout Islamism for the purposes of civil life, independently of all sects and geographical positions, it would be vain to pretend to offer any thing new: the occasion of this paper could therefore only arise from particular circumstances. Thus being lately engaged in a research which required the knowledge of the Christian dates concurring with those of the Hejira, and not having been able to procure any Treatise or Tables that could give me assistance, I prepared the Elements of the present Note for my own use, but without the least intention of communicating it to the public. Being lent, however, to a learned friend (*) who, like myself, wanted access to the Mahomedan Calendar, the original tract, (which contained only a few practical rules for finding the conjunctions on which the beginnings of the Civil years and months of the Hejira, depend) acquired in his hands a public existence for which it never was intended, and in consideration of this unexpected distinction, I was induced to give it subsequently its present form and extension: although, for reasons already stated, I forbore entering into the particulars of a theory which is familiar to every student in Chronology.

When on the revival of the sciences in Europe, the Arabs were resorted to for the embers of that hallowed fire which the Kalif Omar had extinguished, the works of Almamon (1), Alfragan (2), Thebith-Ben-Chora (3), Albategni (4), Arzachel (5), Alhazens (6), and others, drew the attention of all the votaries of science; and even afterward, when its light began to dawn again on the West of Europe, the works of Ulug-Beg (7) proved a farther and fertile source of information. It is universally admitted, that we owe to that successful appeal to the labours of the Arabian Astronomers, some of the most ingenious discoveries in modern Astronomy: but to reap this harvest, it was indispensable to find means for reducing the observations which they had recorded according to their particular account of time, to the concurrent dates of the Christian Calendar, and that work, which was not without considerable difficulties, was performed by the most celebrated Mathematicians of successive ages. Melancton, Christian, Blanchini, Sonnius, Grassius, F. Petavius, F. Riccioli, Wolfius and others, have left nothing to add to their researches. (†) What follows, is a short abstract of their labours.

A. D. 1500.

- (1) See to Astronomi-
Rabbin, altered the
Chron. A. D. 814.
(2) 800.
(3) 800.
(4) 880.
(5) 1020.
(6) 1120.
(7) 1420.

(*) The late Mr. Ellis.

(†) Vide Grassius in commentary on Ulug-Beg; Christianus on Alfragan; F. Petavius in his 7th Book: "De Decretis Temporum;" F. Riccioli's Reformed Chronology; and the Elements of Mathematics of Wolfius.

Common Epoch of
Hijra: 10th July
622.

By most Arabian
Astronomers: 15th
July same year.

Epoch referred to
other accounts of
them.

Common Lunar Syn-
odical year of the
Arabs.

The Lunar year,
month and day, be-
gins immediately af-
ter Sun set.

Cycles of thirty
years.

The years of 12 la-
nar months, and the
months alternately
of 29 and 30 days.
The first month con-
sists of 29 days in
the intercalary
years.

Every one knows that the Epoch of Hijra, or flight of Mahommed from Mecca to Medina, from which all Moslems reckon their Civil year, was found to concur with Friday, the 10th July, A. D. 622.—A certain sect of Ishmaelites, however, (of which were most of their Astronomers) reckoned it from the preceding day; i. e. Thursday, the 15th of July of the same year; a circumstance not to be forgotten when reading their ancient authors. (*)

It was established that the first year of the *Æra* was the 5335th of the Julian period;—Solar Cycle 23—Lunar Cycle 15—Cycle of Indiction 10—and of the *Æra* of Nabonassar (the current year of which began on the 21st March preceding) the 1370th.

The Lunar year was found to consist of 354 days, 8' 49' 36", and the Lunar Synodical month of 29 days, 12' 44' 3". So that the Mahommedan year falls short of the Julian by 10 days, 21' 11" 24" (nearly 11 days); from which it follows that 12 Julian years are equal to 12 years, 130 days, 14' 15' 45" Mahommedan reckoning; and 12 Tropical years are equal to 12 years, 130 days, 12' 1' 45" of the same.

With these data there was no difficulty for finding the concurring Astronomical periods of both styles: but this would not have been sufficient for understanding the Arabian authors, who had recorded their observations according to the *Civil* Calendar used in their own time and country. And as the Arabs had made their Civil day, month and year, begin in the evening immediately after Sun set, on the day after the conjunction, when the Moon's crescent began to be visible, it was found necessary to analyze the system on which their Calendar had been established, and to understand how the mode of assigning the unequal duration of the Civil months, and of intercalating the Civil years, which they had adopted, made each so to keep pace with the Moon's Synodical revolutions, that the beginning of every month always followed the conjunction by the least time necessary for the Moon to become again visible. This was the part of the problem which tried the skill of the European Astronomers: but with which we have at present nothing to do; what follows, being perfectly sufficient for all practical purposes.

The Arabs divide time into Cycles of 30 years, 19 of which are called *common*, and consist of 354 days, and 11 are called *intercalary*, which are of 355 days. The latter, in the order of the Calendar, are the 2d; 5th; 7th; 10th; 13th; 16th; 18th; 21st; 24th; 26th and 29th of the Cycle.

The year of Hijra is divided into 12 Calendar months, which consist alternately of 30 and 29 days; excepting the last month, which in the intercalary years consists of 30 days.

The months are also composed of four weeks, and 1 or 2 days, which differ in nothing from ours.

(*) Vide observation, page 24 infra.

The names of the months are as follows :

		Days.			Days.
1	Mahorum	30	8	Shahaban	29
2	Saffr, or Sepher	30	9	Rhamadan ; or Rumman	30
3	Rabi-el-Avul	30	10	Shawal	29
4	Rabi-el-Ankeer, or Sance	29	11	Zoolcade ; or Zoolcagudah	30
5	Giumadi ; or Giumadi } el-Avul	30	12	Zoolcadge ; or Zoolcagudah	29 or 30
6	Giumadi ; or Giumadi } el-Ankeer	29			
7	Bageb, or Regihab	30			

which last month in intercalary years counts 30 days.

The names of the days of the week are,

Indian Names.		Arabic Names.	
Etwar	1	Yoom-el-Ahad	Sunday
Peer	2	Yoom-el-Thani	Monday
Mungul	3	Yoom-el-Thaleth	Tuesday
Char Shumbel	4	Yoom-el-Arba	Wednesday
Jumma Rhaud	5	Yoom-el-Kamis	Thursday
Jumma	6	Yoom-el-Djooma	Friday
Avul Hafiah	7	Yoom-el-Esfah	Saturday

The Arabic names of the days of the week are : Yoom-el-Ahad, Yoom-el-Thani, Yoom-el-Thaleth, Yoom-el-Arba, Yoom-el-Kamis, Yoom-el-Djooma, Yoom-el-Esfah, &c.

Arabian Astronomers call the weekly day or feria by which the year or month commences, the *Character or Root* of the said year or month ; so that in the Mahommedan Kalender each year and month has its peculiar Root or Character, which serves to find their succession, as shall be explained hereafter.

Thus much it was necessary to disclose of the construction of the Mahommedan Kalender to render the third General Table, and those numbered I. and LI, intelligible. The process for determining the root, and initial feria of every month and year (to begin from the evening of the 16th July A. D. 622, and continue to any subsequent month and year) is fully explained at page 221 of this Memoir.

Roots of years and months, the day of the week on which each begins.

EXPLANATION and USE of the TABLES which refer to the MAHOMMEDAN YEARS.

Of the General Table III of this collection, being the 1st for this Memoir.

This Table gives the beginning of every year of the Hejira from A. H. 1 to 1318, and the Christian concurrent years from A. D. 622 to 1906, according to the Gregorian and Julian styles. It differs from other Tables of the same kind (of which there are several) only in the arrangement of the years, which are here disposed according to their respective roots, or initial feria ; the

Disposition of the General Table III.

figures 1, 2, 3, 4, 5, 6, and 7 in the transverse column at top, indicating that all the years registered under each respectively, begin on a Monday, Tuesday, &c. which roots are indispensable for finding the commencement of the 11 last months of the year. I have preferred this arrangement to the more natural one of following the series of numbers, from local circumstances; and because it facilitates a reference to the beginning of *Iludu* years of all styles, which like those of the *Hejira*, are elicited by their initial feria: so that in many cases their beginnings may be compared or verified by mere inspection. The inconvenience resulting from the interruption of the series, which retards a little the finding of the year sought, is more than compensated by the advantage of avoiding the possibility of mistaking the roots; for the initial feria is known the instant the year is found.

B indicates an intercalary year,

The letter B affixed to any particular year of *Hejira*, indicates that it is one of the eleven intercalaries of the Cycle of 30 years, and that it consists of 355 days.

* that the year is the last of the Cycle of 30 years,

The asterisk * and stroke = above and below the same year, indicates that it is the last of the Cycle of 30 years, and that the intercalations begin anew from that period, according to their permanent order.

Concurring years of the *Calli yug* and *Saca* have noticed,

Each page contains a century of Christian years, and its number is indicated at the top of it. In the margin on each side is entered the first and last concurring years of the *Hejira*; of the *Æra Calli yugam*, and from the birth of *Salivahana*, usually called *Saca*.

In those particular cases where the Mahomedan year begins and ends in the same Christian year (or, which is the same thing, when two years of the *Hejira* begin in the same Christian year), the commencement of both is inserted in the column of the root proper to one of the said two years; so that the other is out of its place; on which account its own character is affixed to it, and these years are repeated twice in the same page. Thus we find A. D. 1258 in the first and third column of the page containing the 13th century, because the roots of A. *Hejira* 656 and 657 are 3 and 1, and that the beginning of both fell in the said year of Christ 1258. I have preferred repeating, to separating these years; because the former method gives a warning which may prevent troublesome mistakes.

From the year 1582, when the Gregorian style was introduced on the Continent of Europe, the notation is registered according to both styles, which was found necessary, because the new one only obtained in England in the year 1752. What remained of years to reach the end of the 19th century, was not of sufficient consequence to alter again the form of the Table. The commencements of the years of the *Hejira* continue therefore to be given till the end, according to old and new style.

EXAMPLE I.

That if I want the Christian year concurring with that of the *Hejira* 271, I look into that page of the General Table III, where 184 (the nearest below that year at the top of any page) is registered.

How to find the Christian year corresponding with any of the *Hejira* by Table III.

in the margin; and finding that it falls in the 9th century and in the column, the root of which is 2, I conclude that it concurs with A. D. 884; that the 1st Mahorah of that year fell on Yoom-el-Thani (Monday) the 29th June O. S.; and lastly, as the notation of the Mahommedan year bears no B, that its last month *Zouledgee*, consists only of 29 days, the year being a common one.

EXAMPLE II.

But if the Christian year 1824 be proposed, and the beginning of the concurrent Mahommedan year be wanted, referring to the same Table where the 19th century is indicated, I find the given year to concur with A. H. 1240, under the root 5, which shews that it begins on a Thursday (Yoom-el-Kamis), and as its notation bears a B, it is a sign that the year is an intercalary one, and therefore, that the last month, *Zouledgee*, consists of 30 days.

For finding the beginning of the intermediate months of the Mohammedan year, by help of the General Table III, it is supposed that the Dominical Letter is known. But although it be not expressed on its face, it may quickly be deduced from the European date and character which indicates the commencement of the year of Hejira.

EXAMPLE III.

For as we have found that the year of Hejira 1240 will begin on the 14th of August *Julian* and 26th *Gregorian* styles A. D. 1824, and as the root for that Mahommedan year was 5 (Yoom-el-Kamis, or Thursday), on referring to any Calendar wherein the Dominical Letters are inserted, and taking the 14th August to fall on a Thursday, we find, (counting three days therefrom) that the Sunday following corresponds to the Letter E, which is therefore the second Dominical Letter of that *Bissextile* year, and F the first according to the *Julian* style.

In the same manner the 26th August falling on a Thursday, the Letter opposite to the next Sunday will be found to be C, the second; and D the first Dominical Letter according to the *Gregorian* style.

But as it seldom happens that the beginning and end of the same year of the Hejira falls during the course of the Christian year in which it begins, the Dominical Letter of the ensuing one is almost always required: but it is sufficiently known to be the preceding one in the order of the alphabet to that previously found.

Of TABLE I., being the second for this Memoir.

As the General Table III only gives the root of the year and Mahorah, it was necessary to establish some means for obtaining that of the remaining months of any proposed year, from which the particular dates might be deduced.

For this purpose a Table was constructed by *Gravius* on the following principle.

As the twelve months of the Lunar year are alternately of 30 and 29 days, the latter begin and end on the same weekly day or feria; and the former end on the next to that on which they began.

How to find the year of Hejira corresponding to any Christian year by the same Table.

How to find the Dominical Letter by means of the General Table III.

Construction of Table I.

its use.

Thus when the month of *Makorum*, which consists of 30 days, begins on the first feria (Sunday) it ends on the 2d (Monday); *Suffr*, which comes next, has only 29 days, and therefore begins and ends on the 3d feria (Tuesday); *Rabi-el-Avul*, having 30 days, begins on the 4th feria (Wednesday) and ends on the 5th (Thursday); and so on of the rest.

Attention to the duration of Zoolledge when the year is intercalary.

The only particular attention required in this process, is to notice whether the year be a common or an intercalary one; because (as has been explained at page 220) in the latter case Zoolledge counting 30 days, ends on the feria next to that on which it began, whereas in common years it ends on the same.

EXAMPLE.

How to find the beginning of every month in the Lunar year.

Let it be required to find the beginning of every month in the year of Hejira 1240.

Referring to the General Table III, where A. H. 1216 stands at top in the margin, with 1240, we find that this year falls in the 19th century, and in the column whose root is 5, which shows that it will begin on a Thursday (*Yoom-el-Kamis*). The letter B, annexed to its notation, indicates also that it is an intercalary year, consisting of 355 days; and therefore, that the month of Zoolledge counts 30 days.

Again, since the same Table informs us that the proposed year begins on Thursday the 14th August 1824, *Julian style*, if we follow the process indicated at page 223, we find that the Dominical Letters for that *Bisextile* year are FE; and for 1825 D, *Julian style*, or DC for 1824 and B for 1825 *Gregorian style*.

With these data we are to proceed as follows:

The character of the proposed year being 5 (Thursday), we turn to the column in Table I, the initial feria of which is 5 at top; and in which we are to continue for the remainder of the year of Hejira 1240.

2. For the month of *Suffr*.

The root of this month, Table I, is 7; i. e. *Yoom-el-Rihab* (Saturday).

To check this, if we count 30 days in the Kalendar from 14th August, we find 13th September; which truly falls on a Saturday.

3. *Rabi-el-Avul*.

Root 1, i. e. *Yoom-el-Ahad*, Sunday; count 29 days from 13th September, and we have 12th October, which also falls on a Sunday.

4. *Rabi-el-Ankeer*.

Root 3, i. e. *Yoom-el-Thaleth*, Tuesday; count 30 days from 12th October, and we have 11th November, and it also falls on a Tuesday.

5. *Gumadi-el-Avul*.

Root 4, i. e. *Yoom-el-Arba*, Wednesday; count 29 days from 11th November, and we have 10th December, Wednesday.

6. Giamadi-el-Aukeer.

Root 6, i. e. Yoom-el-Dglooma, Friday; count 30 days from 10th December, and observe that the Dominical Letter for 1825 becomes D, Julian style; and we have 9th January 1825, Friday.

7. Regeb.

Root 7, i. e. Yoom-el-Effabi, Saturday; count 29 days from 9th January, and we have February 7th, Saturday.

8. Shahaban.

Root 2, i. e. Yoom-el-Thaai, Monday; count 30 days from 7th February, and we have 9th March, Monday.

9. Ramazan.

Root 3, i. e. Yoom-el-Thaith, Tuesday; count 29 days from 9th March, and we have 7th April, Tuesday.

10. Shawal.

Root 5, i. e. Yoom-el-Kamis, Thursday; count 30 days from 7th April, and we have 7th May, Thursday.

11. Zoolcade.

Root 6, i. e. Yoom-el-Dglooma, Friday; count 29 days from the 7th May, and we have 5th of June, Friday.

12. Zoolledge or Zoolcagiadah.

Root 1, i. e. Yoom-el-Ahad, Sunday; count 30 days from 5th June, and we have 5th July, Sunday.

If we wish further to check this operation, say,

To the 5th of July add 30 days (because the year of the Hejira 1240 is an intercalary one, and Zoolledge has therefore 30 days) and you have 4th August, which by the Julian Kalendar falls on a Tuesday, and therefore 3 should be the character for the ensuing Mahommedan year 1241. Referring to Table I, we find in fact that the said year began on the 4th of August, Julian style, and that it bears 3 for root; therefore, the operation has been well performed.

For having the concurrent beginnings according to the Gregorian Kalendar, the process is exactly the same, excepting that a different Dominical Letter must be used.

Thus employing DC, and B, instead of the former Letters, we shall have,

1	Mahorun A. H. 1240	Yoom-el-Kamis	Thursday	26th August.
2	Safr	Yoom-el-Essabt	Saturday	25th September.
3	Rabi-el-Awul	Yoom-el-Ahad	Sunday	24th October.
4	Rabi-el-Akcer	Yoom-el-Thaleth	Tuesday	23d November.
5	Giumadi-el-Awul	Yoom-el-Arba	Wednesday	22d December.
6	Giumadi-el-Akcer	Yoom-el-Dglooma	Friday	21st January.
7	Regeb	Yoom-el-Essabt	Saturday	16th February.
8	Shahaban	Yoom-el-Thani	Monday	21st March.
9	Ramazan	Yoom-el-Thaleth	Tuesday	19th April.
10	Shawal	Yoom-el-Kamis	Thursday	19th May.
11	Zoolcade	Yoom-el-Dglooma	Friday	17th June.
12	Zoolodgee	Yoom-el-Ahad and	Sunday	17th July.
	Mahorun A. H. 1241	Yoom-el-Thaleth	Tuesday	16th August.

Thus it was that beginning from the 16th July A. D. 622, of which the corresponding year of the Hejira was 1 commencing, and whose root was 6 (Yoom-el-Dglooma or Friday), the whole of the General Table III was constructed. It is easy to perceive how that Table may be prolonged at pleasure, to any assignable Epoch whatever.

There remains now only to shew, how to deduce any particular date when the commencement of the months and year have been determined.

How to express
any particular date.

This question presents no sort of difficulty; for let Yoom-el-Thani, the 18th of Shawal, A. Hejira 1240, be proposed.

Having found in the preceding article, that the said month will begin on the 19th May N. S. 1824, add 18 days to that date, and you have Monday, the 6th of June at Sun set, Gregorian style.

In the same manner, let the 15th of January 1825 O. S. be proposed, and its concurrent date in the Mahomedan Kalendar be wanted.

Having found in the preceding article, that the 1st Giumadi-el-Akcer will fall on Friday, the 9th of January O. S. 1825, subtract the same from 15; and the remainder 6, shews that the proposed date will fall on Yoom-el-Kamis, the 6th of Giumadi-el-Akcer.

Of TABLE II, being the third of this Memoir.

How to find the
Hindu Solar year
current on the begin-
ning of any year of
the Hejira.

This Table serves to find by approximation the Hindu Solar year current on the beginning of any proposed year of the Hejira, so that their juxta position may always be determined, excepting in a very few cases, which are so clearly indicated that there is no mistaking them (as will be seen hereafter): but to compare any particular date, recourse must be had to the means which were disclosed in the Memoir on the Hindu Solar year, because the present Tables give only the

commencements of Hindu years concurrent with Christian *Secular years*, which mark the limits of the intermediate years of any century in the scope of three days *Julian* and four days *Gregorian* styles.

The first division of Table LI exhibits the years of the *Hejira*, with their beginnings according to European expression, concurrent with Christian *Secular years* from A. D. 622 to 1900.

The second division gives the Hindu Solar years *Cali yugam* and *Saca*, with their common beginning, according to European expression, and to the *Julian* or *Gregorian* Calendar, both referred to the same Christian *Secular years*, which are expressed in the last column on the right.

Now let it be proposed to determine by inspection what Solar year of the *Cali yug* or *Saca*, commences or ends in the year of the *Hejira* 562?

1^o Refer to the General Table III in that page which has A. *Hejira* 495 at top in the margin; you find that 562 falls in the 12th century, on the Christian year 1166 *Julian* style, and that it begins on the 26th October of that year.

2^o To 1166 add 3102; you have 4268 the notation of the year *Cali yugam* current, and from 4268 subtract 3179, you have 1089 that of the year *Saca*, or from the birth of *Sallyahana*.

Now reverting to Table LI we find (sec. 2) that the Hindu Solar year concurring with A. D. 1100 began on the 23d of March of that year; and that the Hindu year which concurs with A. D. 1200, began on the 21th of the same month; therefore (preceding article) the year of the *Cali yug* 4258, concurrent with A. D. 1166, cannot have begun before the 21d, or after the 23th of March of that year; and as the General Table III gave the commencement of the proposed year of the *Hejira* on the 26th October following, it is manifest that it fell in A. Cal. 4259, and *Saca* 1089, and therefore, that these Hindu Solar years commenced in Anno *Hejira* 561.

In the present case, as the year of the *Hejira* proposed, began so late in the Christian year as the 26th October, and as the Hindu Solar years from A. D. 0 to 1900 commence somewhere in all the month of March, *Julian* style, there was no danger of mistaking the notation of the corresponding Solar years of the *Cali yug* and *Saca*.

But if instead of A. H. 562, which we have expounded, A. H. 1035 had been proposed, then extracting its notation and beginning according to European expression, out of the General Table III, we find it to concur with A. D. 1674, and to fall on the 28th March, *Julian*, and 7th April, *Gregorian* styles.

Now Table LI shews that the Solar Hindu year which concurs with A. D. 1600, began on the 27th March, *Julian*, and 6th April, *Gregorian* styles. And that the Hindu year concurrent with A. D. 1700 began on the 29th March O. S. and 8th April N. S. Therefore, the Hindu year may have commenced either on the same day, or two days before, or two days after the proposed year of the *Hejira*; so that its notation, viz. whether it should be 4817 or 4816 *Cali yugam*, remains

An irreducible case
by the Tables.

doubtful. This case is therefore irresolvable by the present Tables alone, and recourse must be had to the Hindu rule for determining the beginning of the particular Solar year proposed.

But these occasions are so rare, that between A. D. 1500 and 1900 they occur only four times, and in order to render every resolution possible by help of the present paper, I have calculated the commencement of the Solar years of the Cali-yug 4711, 4776, 4841 and 4906, on which the irresolvable case recurs, which, according to European expression, are as follows :

Hindu years.		Chris- tian years.	Years of the Hejira.		Beginning of concurrent Hindu Solar years.	
Caliyug.	Saca.		Old Style.	New Style.	O. S.	N. S.
4711	1532	1609	1018 27th March	6th April	28th March	7th April
4776	1597	1674	1055 28th March	7th April	29th March	8th April
4841	1668	1739	1152 30th March	10th April	29th March	9th April
4906	1727	1804	1219 31st March	12th April	29th March	10th April

It will easily be concluded from this Table, that the 1st Chaitram A. Cali-yug 4711, falls on the 2d Mahorun A. Hejira 1018.

1st Chaitram A. Cali-yug 4776—2d Mahorun A. Hejira 1055.

1st Chaitram A. Cali-yug 4841—29th Zoolledge A. Hejira 1151.

1st Chaitram A. Cali-yug 4906—28th Zoolledge A. Hejira 1218.

Given the years of
the Cali-yug or Saca,
how to find that of
the Hejira.

The converse of this proposition is still of easier solution ; for suppose that the year of the Cali-yug 4940, or 1761 Saca, be proposed, and that it was found to begin on the 11th April A. D. 1838 N. S.

Then referring to the General Table III we find at once that its commencement fell on A. Hejira 1254, the beginning of which occurred on the 27th March N. S. But as that Mahomedan year lasts only until the 11th April following, it is manifest that the commencement of A. Hejira 1255 will also fall in the same year Cali-yugam 4940 ; but that from the 6th Mahorun the year of the Hejira 1255 will concur with A. Cali-yug 4941, and Saca 1762.

It will be observed, that the irreducible case adverted to in the preceding article, does not exist on this side of the question ; for as the feria beginning the Hindu Solar year, and its date according to European expression, are supposed to be given by the proposition, the General Table III shews at once whether that date falls before, or after the commencement of the concurrent year of the Hejira.



NOTE I.

On the juxta-position of the beginnings of the Mahomedan Lunar and Hindu Luni-solar years.

If the *Chandra mana* had not been subjected to intercalations which have no analogy to those which are used in the Arabian Kalendar, there would have been no difficulty in comparing dates proposed in these two accounts of time, the difference of their periods being so very trifling, that for a great number of years it might have been neglected without inconvenience. Here follows a comparative view of the respective Lunar years and months on which the operation would depend.

Mahomedan and Hindu Luni-solar periods compared.

	Hindu time of 60 guddias to a day.					European time in hours.				
	D.	G.	V.	P.	S.	D.	H.	'	"	°
Hindu Lunar year (Surreah Siddhanta)	354	22	1	23	57	354	8	48	33	34,8
Arabic	354	22	1	30	0	354	8	48	30	0,0
Difference, Arabic		+		6	3					2 25,2
Hindu Lunar month do.	29	31	50	6	59	29	12	44	2	47,6
Arabic	29	31	50	7	30	29	12	44	3	0,0
Difference, Arabic		+		31						12,4
Thus whilst the Arabian Synodical Cycle of 30 years consists of (*)						10631	0	18	0	0
The same number of Hindu Lunar years is						10631	0	16	47	24
The difference being in 30 years										1 12 36

But although the Hindus really add or retrench nothing in their computations of Astronomical periods, yet as the construction of their Civil Kalendar requires every two or three years the intercalation of the *name* of a month, whilst time follows its regular course, and as the Arabs only intercalate days, all that can be done is, after computation of the same, to compare the *Prathama Tithis* which begin each Lunar month and year, with the dates of the Civil beginnings of some Mahomedan month which fall nearest to them and which never differs more than a couple of days therefrom, but which will not recur as to *names* in a similar series, for reasons which it is unnecessary to repeat in this Memoir.

The beginnings of the Mahomedan and Hindu Luni-solar months may be compared without any reference to names.

(*) The Civil Arabic Cycle is thus constructed.

19 years of 354 days	-	-	-	-	67261
11 years of 355 days	-	-	-	-	3905
Number of complete days	-	-	-	-	10631

As for referring the Hindu Tithis, or Lunisolar days of the Hindu year, to those of the Mahomedan Kalendar, it would be vain to attempt it by any mechanical process; a Tithi being the space of time which is requisite for the Moon to move through 12° of her path, to or from the Sun, and consequently beginning at no fixed instant of the day or night.

Computation of the conjunction which preceded the beginning of the Era of Hejra, by the Vakiam, or Solar process.

Comparison of the
juxta position of the
beginning of the first
year of the Hejra,
and of the month
Rabi-ul-hidja of the
Lunisolar year
5724 of the Cali yug.

We have seen at Example V, page 38, of the Key to the Madhyama Saur-mana, that the first Civil day of the Hejra, according to vulgar account, viz. 10th July A. D. 622, fell on Friday the 25th Audi of the 5724th year of the Cali yug; but that Hindu Solar date was deducted from the European one, and not computed on the principles of Indian Astronomy, which we shall do in the present Note; and as independently of its peculiar interest, it presents a case where the Ahargana is less than a Vedam or 1600984 days, (hitherto not considered), I shall insert it at full length for the reader's information. The computation will be referred to the supposed Meridian of Trivallore.

The Aharganas resolved in the usual manner, or by Tables XLVIII and XLIX, will be

Solar.				Lunar.					
	D.	G.	Y. P.		D.	G.	Y. P.		
1st Chaitram 5724	-	-	-	1355835	55	12	30		
add 3 Solar months, Tab. XLVIII,	93	56	22	3	add 4 Lunations, Tab. XLIX,	118	7	20	12
1st Audi	-	-	-	1355929	51	34	33		
				+ 24				+ 1	
25th Audi commencing				1355973	51	34	33		
				60					
or 24th when the time wanting									
of Sun rise was	-	-	-	8	25	27		24	

Dividing the respective Aharganas by 7, the Santa dinas will be, *The Sun, Thursday; The Moon, Wednesday*; and the Dominical Letter being expounded by Tables V and VI, is C, giving Wednesday the 14th and Thursday the 15th July 622.

For finding the Moon's place we are therefore to compute her *Druva, Chandra Vakiam, Dhur-maranham*, and *P'hala*, by her Ahargana above found, which being only 1355973, shows that it bears not division by a Vedam.

Vedam		100 x		8 x	
1600984	1355973	100 x	3 27 48 10	8 x	2 0 30 10
Iluz, Gherica 12372	1355973	8 x	11 7 31 3		0 23 33 0
	12372	12 x	0 27 33 6		5 0 36 54
	12373				
	141348				
Calanillam 3031	11425	Equation of Vakiam 100, Table XXVI,			8 2 40 13
	9093				8 1 17 0
Devaram 243	2332	3's place uncorrected			4 3 57 13
	2222				
Chandra Vakiam	100				

In order to find the Moon's *true* place, compute that of the Sun at his rising on the same day, 25th Audi commencing:

On the 1st Audi the Sun entered the Sign Carcati ☿ the 4th of the Zodiac. He had therefore completed

To which add for 24 days, + 24 0 0

And as on his entrance into the new Sign there wanted of Sun rising

8° 25' 27", add the guddias as calas and viguddias as vicaleas . . . + 8 25

☉'s Samsa place on the 25th at Sun rise 3 24 8 25

And his Equation by the Yoghiadi Table (XXVII, part 1) being —

(22° + 23° + 24°) for 24 days complete, and 22° for 8° 25', we have 1°

2° + 22°, which subtract — 1 0 22

☉'s Spata Graha or true place, 25th Audi 3 22 59 3

For the Moon's place corrected.

Having found the Sun's *true* place, we may now correct that of the Moon, as follows:

☾'s place uncorrected 4 3 37 13

By Table XLVII, we find the *Desentaria calas* for the preceding month Audi II + 7 0

For the andravicalas (same Table) we find + 2, and the odd degrees, minutes and seconds of the ☉'s apparent Longitude being: 22° 59' 3"

Multiply by × 2

The 1st Equation will be 45° 58" 6" or 27 + 46

For the 2d Equation. As the Moon is more advanced than the Sun, from Table XXVI take her true motion for Chandra Vakiam 160, 814'

And her mean motion being 791

Difference 23

Now after division of the Abargana by the three last Elements there were, among the rest, 9 Desantams, to each of which are due 32", which gives $9 \times 32'' = 4' 48''$, to which multiplying by the difference 23' gives 4' 14" 24", which because the ☾'s *true* is greater than her mean motion, add

+ 4 14

☾'s Spata Graha, or apparent place, 25th Audi at Sun rise 4 4 0 13

☉'s do. . . . do. present page 3 22 59 25

☉ and ☾'s apparent distance at do. 11 9 48

For the Sun's true motion.

By the Yeghiadi Table (XXVII, part 1) the Equation of the Sun's motion for 8 days to come on the 24th Audi complete, is $-22'$ —therefore for that day it is $\frac{-22'}{8} = -2' 43''$

Which subtracted from	-	-	-	60
Gives the ☉'s Sputa Gati, or true motion sought	-	-	-	<u>57 15</u>

For the relative motion.

☿'s Sputa Gati	-	-	-	-	844' 0"
☉'s do. do.	-	-	-	-	<u>57 15</u>
Relative motion	-	-	-	-	<u>786 45</u> . 13' 0' 45"

For time due to distance.

$$13^{\circ} 0' 45'' : 60'' \text{ (one day)} :: 11^{\circ} 0' 48'' : 51^{\circ} 4' 51''.$$

And because at the time of Sun rising on the 25th Audi, the Moon's apparent Longitude, was greater than that of the Sun, it shews that the conjunction was past, therefore subtracting the quantity above elicited from

$$\begin{array}{r} 60^{\circ} 0' 0'' \\ 51 \quad 4 \quad 51. \end{array}$$

We have the true time of conjunction, 24th Audi 3724

$$\begin{array}{r} 8 \quad 25 \quad 9 \end{array}$$

The preceding result (though only an approximation) is perfectly sufficient for our present purposes, and shews that according to the Rules of Indian Astronomy, the conjunction which preceded the 1st Civil day of the Hejira fell some time in the morning of the 24th Audi A. Cal. 3724, and therefore the *Pratham* Tidhi of the Lunar month *Bhādrapada*, on the 25th, answering to Thursday the 15th July A. D. 622, which is precisely the day referred to by most Arabian Astronomers as that which begins the Hejira.

This coincidence may give rise to some speculations respecting the authority which was originally consulted when the Epoch of the *Flight* was determined. For at the time when the prophet unfurled the standard of the faith, the Arabs had certainly no Astronomy of their own, and probably none at all of others; and although he may have resolved on assuming the day of his exile for the first of his new era, the task of fixing it permanently must have devolved on his successors.

But the Alexandrian School and Library, were destroyed on the 2d *Mahorum* of the 21st year of the Hejira, a time too near the beginning of the revolution to suppose that it may have been previously consulted on the construction of a new Kalendar. It is therefore more probable, that when in more settled times, Mahommed's successors resolved on that measure, they may have had recourse to their Indian neighbours, who since the destruction of the Alexandrian School were the only nation in the East who cultivated the sciences.



NOTE II.

On Dr. Hutton's Rule for finding the year of the Hejira.

It is difficult to understand on what principles Dr. Hutton has established the Rule which he gives in his Mathematical Dictionary for finding the Christian year concurring with any proposed year of the Hejira: it runs as follows:

"Reduce the given years of the Hejira into days by multiplying by 354, divide the product by 365½ and to the quotient add 622 years of the Hejira commenced."

[Mathem. Dictio. Vol. I, page 593.]

I fear that this rule is more remarkable for its brevity than for its accuracy (for the above passage contains the whole of the Rule). If it were sufficient to multiply the proposed years of the Hejira by 354 for obtaining the sum of days elapsed since its Epoch, what becomes, it may be asked, of the eleven intercalated days in the Cycle of 30 years, which make the years on which they fall be of 355 days, and in the course of 30 years retard the beginning of the Civil year by 33 days?—Let us try the merits of this rule by its results.

Let it be proposed to find the Christian year concurring with A. Hejira 1215.

We have $1215 \times 354 = 430110$; and $\frac{430110}{365\frac{1}{2}} = 1177, + \frac{210,15}{365,25}$ and lastly $1177 + 622 = 1799$.

So that following the letter of the precept A. H. 1215 would concur with A. D. 1799, which however, throughout Christendom and Islamism is taken to be 1800: the 210 days which remain after division by 365½ are insufficient to account for such a difference, although they would bring the epoch of coincidence about 7 months later (206° 17' 8' 31" being equal to that number of Lunar months), but these odd days end at no definite period; and no notice is taken of them in the precept: We are therefore compelled to conclude, that the very learned and justly celebrated author has only glanced at a subject which it did not enter into his views to investigate minutely, as may be inferred from the shortness of an article which, though intimately connected with Astronomy, was disposed of in twelve lines of his Dictionary.



POSTSCRIPT.

Some time after the *Kala Sankalita* was committed to the press, Mr. Bentley's posthumous work, entitled "An Historical View of the Hindu Astronomy from the earliest dawn of that science, down to the present times" came to my hands, having just appeared for the first time in Madras, though published in Calcutta two years before.

On a cursory perusal of that production, (which remained only a few days in my possession, and at a time when I was engaged in editing the present work), I congratulated myself on having pursued an object totally different from that which Mr. Bentley had in view: For it was then too late to have benefited by his instruction; and in case of collision, with such unequal means and powers, I would have had cause to apprehend the judgment of the public on the issue.

Fortunately for me, Bentley soared to the highest regions of investigation, whilst I was collecting tools for labour, and toiling in the lower walks of research. He strove to drive error from the seat of truth, whilst I was employed in shewing how she ruled the population of the East, during many centuries of usurpation; in fine, his object was philosophic, and mine merely one of practical expediency. Our works may therefore (with an inverse degree of applause and censure) subsist together, and prove useful in their respective departments.

It will be observed that the abolition of Syderal Astronomy pronounced by the work alluded to, to have taken place from the Vith century upwards, renders a great part of my speculations unavailing; to which I shall reply that, although agreeing in substance to a doctrine which the scholast has so ably supported, yet I do not go with him the whole length of believing that the use of Ancient or Tropical Astronomy, was so suddenly relinquished, and the Syderal so readily adopted, as might be inferred from the *precise Epoch* which he assigns to that event (March A. D. 538, page 73). It required nearly two centuries to drive the Aristotelean philosophy out of the Universities of Europe, and arguing from analogy, it is not to be supposed that a people, of all others the most attached to its institutions, would have simultaneously adopted new theories, when the old ones were still found to answer, (and were in reality better than the new), for no other purpose than "to appear the most ancient nation in the universe (70);" for, although I do not pretend to say that Mr. Bentley meant to convey absolutely such a notion, yet his text bears that construction.

Before the Epoch referred to, the Syderal Astronomy (certainly the most commodious of the two) must surely have thrown out some roots in the minds of the learned men of those times, and have lurked, perhaps during several centuries in the public opinion. Some sect of philosophers must have taught it; and some separate tribe or nation must have counted time by the same, before it became the general doctrine of India. And from the same considerations it may be believed

that Ancient Astronomy has left shoots which it must have taken time to extirpate. Nor can I believe that the Braminical power, (which rests entirely on opinion, great as it now is, and has been) can have proved so efficient as to have occasioned the sudden and total overthrow of the latter, in the same manner as Timur Long, and Nadir Shaw subsequently annihilated their public institutions. It is therefore highly probable, that Sydereal Astronomy began to be in repute, some hundreds of years before it openly superseded the Tropical one; and as to the motive of its abolition, I cannot be persuaded that the specific purpose of any set of men, when effecting a change can have been *to do away their Ancient History* (page 70).

Some old documents (and particularly inscriptions) may therefore still be found bearing dates in *Sydereal account*, more ancient than the Epoch assigned to its legal admission, and to those my Tables will apply. I beg it, however, to be understood, that I intend no review of Mr. Bentley's valuable production, for which I have neither leisure, means, nor abilities; most of his conclusions appear to me decisive, and, more than all the rest, those which attack the unfathomable antiquities of the Hindus. But I did not wait for the appearance of the "*Historical View*" to decide against them; for although unacquainted with Bentley's discoveries, I have long since been persuaded, and have declared it to be my opinion, that their periods and yugs were nothing else but mathematical contrivances, resting at one end on observations taken at the time when they were invented; and at the other, on some Epoch so very remote, that the greatest possible error in the position of the Planets at the time referred to (which could never exceed 6 signs in Longitude) must become almost insensible in their annual revolutions, and unimportant until after a great number of years intervene, either before or after the time of invention.

There is something so obvious in this view of the subject, that it cannot be wondered at, if Bentley fancied (though erroneously) that the attacks made on his doctrines were designed for him, personally. Another motive, perhaps equally reprehensible, was I fear, the hidden cause of their having been so frequent and repeated. In France I can affirm, on the *verbal* and *written* assurance of the late M. Delambre, that Bailly's doctrines never obtained any proselytes among men of real science; and when on a particular occasion the celebrated *La Place* asked me (*) whether we Indian Gentlemen, and Members of the Asiatic Society, believed that any of the Indian periods were established on actual observations, on my assuring him of the contrary he expressed much satisfaction, and replied that he was sure such a notion could never have been long entertained by any *Savant*.

But I fear the author of the "*Historical View*" more justly ascribed the perseverance of some of his critics, to a bent towards infidelity, which in some instances was hardly denied; such was the prevalent philosophy at the close of the XVIIIth century. But as *scepticism* has now

(*) At a meeting of the Board of Longitude in April 1816.

succeeded to incredulity, and as the ruling notion of the beginning of the XIXth, is that *any thing may be true*, I have no doubt that the doctrines contained in that most profound work that has hitherto appeared on Hindu Astronomy, will meet with little or no opposition from any quarter; at least from such as the author need have cared for if he had lived to enjoy the success which I anticipate.

Whatever be the final opinion of the scientific world on the antiquity of Syderal Astronomy, and the manner I have applied it to the construction of the Hindu Kalendars (which was the only province I was desired to investigate), I commit the present work to the judgment of the public with no sanguine expectation of success; but with a sincere desire that it may, (in its measure) prove useful to Chronology. Should I be disappointed in that expectation, I shall be consoled by the recollection of the amusement it has procured me during several years; and the opinion it has enabled me to form of the skill and ingenuity of the Natives of India, which, though duly appreciated by many of their rulers, is not sufficiently known to the great mass of Europeans who live among them.

END OF THE FOURTH MEMOIR.

APPENDICES.

APPENDIX I.

On the manner of computing the Ahargana for the beginning of the Solar years, and end of the Luni-solar years, counted from the commencement of the Cali yug, by means of the Tables, from which the Strosidli digona and Soota dina for either may easily be deduced.

ALL the Rules given in Hindu books for the resolution of the *Ahargana*, are very obscure, and consequently liable to mistakes in the computation. It will be found, however, that in the Indian process, that Element is unnecessarily wrapped up in mystery; and that both the Solar and Luni-solar *Aharganas* may be obtained with perfect accuracy, by help of Tables which are neither difficult to use, nor to understand.

I shall first consider the Solar Table XLVIII, which is divided into two parts, the first giving the *Ahargana* according to the *Surriah*, and the second to the *Aria Siddhanta*.

According to the former *Sastra*, the duration of the diurnal revolutions of the Stars in one year is $\frac{1177777777}{1177777777} \cdot 365^{\circ} 15' 31'' 31' 24''$ and $1532237638 - 4320000$, is the number of *Bhumi savan* (natural) days in a *Maha yug*; hence the Solar Syderal year, according to the *Surriah Siddhanta* is $\frac{1177777777}{1177777777} \cdot 365^{\circ} 15' 31'' 31' 24''$, and this quantity is the constant ratio of the first part of the Table.

Table XLVIII,
part I.

Number of diurnal
revolutions of the
Stars in one year.

In the same manner the diurnal revolutions of the Stars in one year according to the *Aria Siddhanta* is $\frac{1177777777}{1177777777} \cdot 365^{\circ} 15' 31'' 15''$; and $1532237600 - 4320000 = 1577917600$, is the number of *Bhumi savan* days in a *Maha yug*; consequently the Solar Syderal year is $\frac{1177777777}{1177777777} \cdot 365^{\circ} 15' 31'' 15''$, which is the constant ratio of the second part.

Solar Syderal year
Surriah Siddhanta.

Do, *Aria Siddhanta*.
12.

Lastly, we have shown at page 12, 1st Memoir, that because the year which opened the *Cali yug* began $4^{\circ} 51' 8'' 45''$ from the commencement of an entire week, the Hindus, with a view to reckon from a complete period, added a *Cshapa* of $2^{\circ} 8' 51'' 15''$ (complement to 7 days) to the *Ahargana*, which was the same thing as retrenching it from the Epoch itself.

It is therefore always to be remembered, that with respect to the true Epoch of the *Cali yug*, there will be found that difference in the Tabular results.

For let the Christian date of the Yugadia, or first day of the Cali yug, be sought; proceeding as shown at Example 5, page 26, with Table VI, and at the Example in page 50, with Table VIII, we shall find

Calcp or Equation
to a complete week.

	D.	G.	V.	P.
Initial Root A. A. C. 3101	(2)	31	8	45
Add Calcpa	(2)	8	51	15
Root sought	(5)	0	0	0
Friday.				

Date of the Cali
yugadia 18th Februa-
ry A. A. C. 3101.
By the Tables 10th
February.

And as the Dominical Letter for that year will be found to be B, the Yugadia under consideration falls on the 18th February of the year before Christ 3101 current, whereas the Hindu Tabular date, gives only the 16th.

As the Hindu Tables for finding the time of the Sun returning to the beginning of the Solar Zodiac, are affected by this Equation, it must be accounted for when calculating the Solar Ahargana; observing that, if computing from the Epoch the *Calcpa* becomes a *Sodhyam* or constant Equation to be subtracted from the aggregate sum of days, guddias, &c. reckoned from the assumed Epoch as given in the Table.

The preceding considerations will suffice for explaining the construction of the first and second parts of Table XLVIII; we shall now give some Examples of their use.

EXAMPLE 1.

Example 1, 1st part
of Table XLVIII.

1^o Wanted the Solar Ahargana for the beginning of the Solar year 4924 of the Cali yug, or 4923 complete, answering to A. D. 1822, according to the Surriah Siddhanta.

	Y.	D.	G.	V.	P.
By Table XLVIII, part 1, we have for 4000	-	1461035	1	33	20
900	-	328732	52	51	0
20	-	7305	10	30	28
3	-	1095	46	34	31 12
		1798168	51	29	22 12
Subtract Sodhyam		-	2	8	51 15 0
1st <i>Mesha masha</i> Y, or modern <i>Vaisâcha</i> ; and Tamil <i>Chaitram</i> , Ahargana sought	-	1798166	42	28	7 12

And for the Soota dina 7)1798166(25688

with a remainder of 6 which counted from Friday, shews that the Soota dina or initial feria falls on Thursday.

2^o Wanted the Ahargana for the 1st of the Solar month *Vrischika masha* ॐ; the modern *Mârgasiras*; and of the Tamil denomination, *Cartiga*.

	D.	G.	V.	P. S.
Ahargana, 1st Vaisâcha, above found	-	1798166	42	28 7 12
Add collective number of days registered in the 1st column down to Cartiga	-	216	48	13 18 39
Ahargana, 1st Margasiras; which divide by 7)	1798382	(30	51	25 51

remainder 6 and counted as usual from Friday, gives the Soota dina on Thursday.

There being not the least difference from what precedes in the manner of using the second part of Table XLVIII, and all cases, either according to the *Surriah* or *Aria Siddhanta*, being to be resolved precisely in the same manner, I shall dispense with giving any more Examples for the Solar *Ahargana*,

To find the Luni-solar Ahargana by means of Table XLIX.

The construction of both parts of this Table, is as simple as that of the preceding one. Its whole theory rests on what follows,

For the Luni-solar
Ahargana, Table
XLIX.

According to the *Surriah Siddhanta*, there are 57753336 periodical revolutions of the Moon in a Maha yug or 1577917923 natural days. Hence the Moon's periodical month is $\frac{1577917923}{57753336}$, or $27^{\circ} 20' 20'' 21^{\circ} 30''$, 77, &c. ($27^{\circ} 8' 8'' 8' 30''$, 6 European time.) From the number of periodical revolutions in a Maha yug, subtract the number of Solar days in that period, or 57753336 — 4320000, you have the number of Synodical revolutions in the same time, = 53433336; and $\frac{1577917923}{53433336}$ or $29^{\circ} 31' 30'' 6'' 30''$, 73 ($29^{\circ} 12' 44'' 2' 47''$, 6 European time) is the duration of a mean Lunation, according to the *Surriah Siddhanta*: a mean Lunar year of 12 months is therefore equal to $354^{\circ} 20' 1'' 23'' 57''$, 14 ($354^{\circ} 8' 48' 33' 48''$ European time) which is the constant ratio of the first part of Table XLIX.

First part.

That of the second part is deduced from the same principles, the only difference being that the *Aria Siddhanta* counts only 15779173200 natural days in a Maha yug. According to that authority the Moon's periodical month is therefore $27^{\circ} 19' 17'' 59' 20''$ &c.; the Synodical $29^{\circ} 31' 50' 5' 40''$, 21, and the Lunar year of 12 months $354^{\circ} 22' 1' 2' 2''$, 6 which is the constant ratio of the said second part.

Second part.

Considering how very intricate the process is for finding the *Adigah* months and *Udaya Tidhis* by the *Sastra* rule (*), I originally concluded that there could be no simpler means for finding the Luni-solar *Ahargana*, and when from stress of labour I endeavoured to free myself by means of Tables, from those perpetual rules of three which it imposes, a typographical error in Mr. Davis' paper on the Astronomical computations of the Hindus (+), making the Lunar Synodical month $29^{\circ} 31' 50''$, 6 instead of $29^{\circ} 31' 50''$, 6 &c. for a long time defeated my endeavours. But when once I had discovered the *erratum*, there was no further difficulty in constructing my Table, which I subjected to the following test.

We have seen in the article of *mean intercalations*, Part III, Article I of the second Memoir, that the period of recurrence of an *Adigah* month was $2y 8m 16d 3g 35'$ &c. and I resolved the same by means of the first part of Table XLIX, as follows:

Epochs of intercalations by the Tables.

(*) Vide Key to the *Siddhanta Chandra Mana*, Part II, Article L.

(†) *Asiatic Researches*, vol. II, page 222, English Edition, which teems with errors of the most fatal kind to the true exposition, and acquisition of the first notions of Hindu Astronomy, from that otherwise, elegant production.

The mean Solar Sydercal year being	-	D.	G.	V.	P.	S.
And the Lunar year of 12 months	-	365	15	31	31	24
The annual difference is	-	354	52	1	23	57,14
So that for one month of 30 days the Equation is	-	10	52	30	7	26,80
And for one day of 60 guddias	-	54	27	30	27,23	
	-	1	48	55	1,273	

If with these quantities we expound the period of intercalation referred to, we shall find

For 2 years	-	D.	G.	V.	P.	S.
" 8 months	-	21	47	0	14	53,72
" 16 days	-	7	15	40	1	57,84
	-	29	2	40	20,07	

Which subtract from 1 mean Lunation	-	20	51	42	57	11,53
	-	29	31	50	6	50,78
Difference	-				7	9 48,13

and for the time due to this difference say, as $1^{\circ} 48', 51$ (the Equation for one day), to 3600 (the number of viguddias in a day of 60 guddias); so $7^{\circ}, 15$ &c. (the difference to a mean Synodical month), to $3^{\circ} 55', 8$ &c. which, with the above quantities, gives the time due to the intercalation of one mean Lunar month, $27^{\circ} 8' 10'' 32' 55'', 8$ &c. very nearly the same as was found by the Hindu rule referred to.

Having premised thus much, I shall give the following Precept and Example.

PRECEPT.

- 1^o Find the Solar Ahargana for the proposed year of the Cali yug, which will serve as an Index for finding the Luni-solar one.
- 2^o Take out of the two first columns of Table XLIX, part 1, the quantities answering to as many Lunar years of 12 months as there are Solar ones proposed, and add them together: the rest of the operation will serve to find the intercalations.
- 3^o Subtract the sum of days, &c. so obtained (neglecting the fraction) from the sum of days of the Solar Ahargana, and take out of Table XLIX the quantity nearest to the remainder, which write both under the Lunar sum and the remainder of the Solar Ahargana, of which take again the difference; follow the same process as before until the last remainder under the Solar Ahargana be less than a mean Lunation, which in that case neglect.
- 4^o Cast up all the Lunar periods so obtained, and the sum will be the Luni-solar Ahargana sought.

N. B.—This process has the advantage that in no case whatever the Luni-solar, can exceed the Solar Ahargana, which is not the case in the Sastris rule, and that it shows at once the number of intercalary months which have been introduced in any proposed interval. The Precept applies equally to part 1 and 2 of Table XLIX.

The same by the
Hindu rule.

Find the Solar Ahargana of the proposed Luni-solar year for an Index.

Manner of using the Table.

EXAMPLE II.

Wanted the Luni-solar Ahargana for the end of the year of the Cali yug 4923, by part 1.

Rule.

Table XLIX, part 1, column 2		Y.	D.	O.	V.	P.	S.
Sum of days in the Solar		4000	1417468	13	16	40	20
Ahargana found by Table		900	318230	20	20	17	0
XLVIII - 1798100		20	7087	20	27	20	2,8
(1) - 1714549		3	1063	6	4	11	51,12
		(1)	1714549	0	43	17	10,22
(2) - 35436		100 (2)	35436	42	19	55	14
		30 (3)	17718	21	9	27	37
		1 (4)	554	22	1	23	57,14
(3) - 17718		3 Lunar months (5)	88	35	30	20	59,34
		Ahargana sought	1798147	1	49	55	7,70
(4) - 554		By the Tellinga rule	1798147	1	50	32	0
		Difference	-	-	36	52,3	
(5) - 88		But as the day current is wanted, and as 1g 49r 55p have already expired of it,					
Neglect remainder 21		To 1798147					
		Add 1					

Ahargana to be used 7)1798148(256878

Remainder 2 i. e. Saturday the Sonta dina;

and as this Element is only used to the nearest day, the difference of 36,5 paras, from whatever it proceeds, is of no sort of importance.

As 131 Lunar years and 3 months have been intercalated for bringing the Luni-solar to the nearest possible time of the Solar Ahargana, it follows that in 4923 Solar Syderal years (account of the Surriah Siddhanta) there have been 1815 Luni-solar months intercalated.

For the Strothli digona,

Lastly, if to the constant number	-	-	-	71440296827 days
We add Ahargana	-	-	-	1798148
We have the Strothli digona for A. C. 4923	-	-	-	714404094775

as accurately as if it had been computed by the process explained in the 1st Article of the 2d Part of the *Key to the Siddhanta Chandra Mana*.

The rule by the second part of Table XLIX being precisely the same as the preceding one, *mutatis mutandis*, no Example is necessary; I shall only state that the Ahargana

2d part of Table XLIX.

according to the quantities used in the Aria Siddhanta for the same year is 1798146 [39 24 28 53,0

And consequently for the current day - - - + 1

And for the Sonta dina - - - 7)1798147(256878

remainder 1 which counted

from Thursday, gives Friday for the Sonta dina.

Here it may be observed that according to the Surriah Siddhanta,

the Ahargana was

And by the Aria Siddhanta	-	-	-	1798147	1	49	55	7,7
	-	-	-	1798146	39	24	28	53,0
Difference	-	-	-			22	29	26 14,7

Difference of Luni-solar Aharganas by the Surriah and Aria Siddhantas.

Of no consequence.

So that although by the *Soota dina*, there seems to be one day of difference for the conjunction, yet there is in fact only $21^{\circ} 25' 26'' 14,7$ disagreement between the two accounts, which difference is of no sort of importance, because in the computation of the Tithis, the Sun and Moon's real positions in Longitude at mean midnight at Lanka, and not the time wrought by the rule, are what determine the beginning of the Lanna month, which will find its true place whether we use *Friday* or *Saturday* as the day to work for.

Generally the Southern Astronomers, though working in Solar time, prefer making use of the Lunar *Ahargana* of the *Surish Siddhanta*.

Case where the Lunar solar is greater than the Solar *Ahargana*.

It sometimes, though rarely, happens that on certain years (as will be the case at the end of the 4251st year of the Cali yug, answering to A. D. 1836) on computing the two *Aharganas* by the *Sastra* rules, the *Lunar solar* will be found *greater* than the *Solar* one; which would seem to indicate that the *Chandra Mana* begins, *after* the Solar year: but in such an occurrence the rule

An intercalary month is to be intercalated when using the *Sastra* rule.

directs that an intercalary month be retrenched, from both *Aharganas*, and that the antecedent conjunction determines the beginning of the new Astronomical year. This of course disturbs temporarily the order of the intercalations; and is the cause why the original series in the Cycle of 19 years undergoes a change in its disposition (*): but the only consequence in the Calendar is, that as the year on which the case occurs would have been *embolismic*, it becomes a common one, and that the following one from common that it would have been, becomes an intercalary one. On working the two *Aharganas* by the Tables XLVIII and XLIX, there can be no fear of a mistake respecting the true commencement of the *Chandra Mana* arising from the above cause; because by the Precept, the Lunar is unavoidably kept below the Solar *Ahargana*.

Not to be cared for when using the Tables.

(*) Vide page 10.

END OF APPENDIX I.

APPENDIX II.



Describing a particular method for expounding dates found in old Inscriptions, the only vestiges of which consist of the recorded years expired since the beginning of the Kali yug, from the birth of Salivahana or of the Cycle of 60 years, and of the Sun's apparent place in the Hindu Syderent Zodiac at the time of the commemorated event, and also, for referring the Epochs of ancient phenomena recorded in European time, to their corresponding Hindu Solar dates.

Object of Appendix II.

THE questions under consideration are to be resolved by means of certain formulæ which enable the computer to refer the Sun's mean place in the Indian Syderent Ecliptic, as deduced from the time assigned to his entering any of its Signs in the Solar Kalendar, to his mean place in the European Tropical Ecliptic, at the same instant of time, by one single operation; thus affording means for correcting the Hindu Solar Tables, and also those of the Planets, as far as the computation of their position depends on the Sun's place and the beginning of the Syderent Zodiac, the duration of the Solar year being $365^{\circ} 15' 31'' 18''$.

To refer the Sun's mean place in the Indian Syderent Ecliptic, to his mean place in the European Tropical Ecliptic, by one single operation.

I have stated in the Preface of this work (page iv), that my intention was to expound the operations of the system now generally in use in those parts of India, as if it had been followed during all past ages, and were to continue to be so to the end of time; and in the present tract my purpose remains unaltered, although I profess to be one among those who have no faith in that proposition. Any person who has looked into books of Hindu Astronomy knows, that in remote times the Solar year was made to begin successively with the months Aswina (now the 6th of the year), Carica, Margashira (*), Pousha, Magha, Phalguna, Chaitra, and lastly Vaisakha (†); the line of the *Riksha* or *Rishis* (‡) intersecting at the corresponding times the first points of

The present Hindu system of Astronomy supposed permanent.

Not so in reality.

(*) The name of which was changed into that of Agrahayan on that occasion.

(†) In the present paper I shall use the Bengali denomination of the Solar months in preference to that of the Tamil, being more generally known; though, from the Bengali names being the same as those of the Lunar months, the latter be less convenient, because less distinct.

(‡) The line of the *Riksha*, as called in Tylogana, and *Rishis* in Bengal, is a great circle passing through the Pole of the Ecliptic, uniting a certain Star in the Constellation of the Great Bear, called *Maha Riksha*, supposed by some to be β , by others to be γ or δ Ursa Majoris, and meeting the Hindu Yoga Star *Fuldhara*, believed to be the same as ζ Piscium, although no great circle passing through the Pole of the Ecliptic could be made to intersect with any precision, any three of these points.

the Lunar mansions *Chitra*, *Pulsatilla*, *Jyotisha*, *Purva Ashadhâ*, *Scravana*, *Satishkha*, *Uttara Bhâdrapada*, and lastly *Âswini*, which according to present theories, marks the beginning of the fixed Lunar and Solar Zodiacs.

Epochs of the various beginnings of the Hindu Solar year the subject of much discussion.

Not considered in this paper.

The Solar Syderal system supposed to have been introduced in A. D. 518.

Uncertainty of the methods hitherto used for expounding ancient Hindu dates.

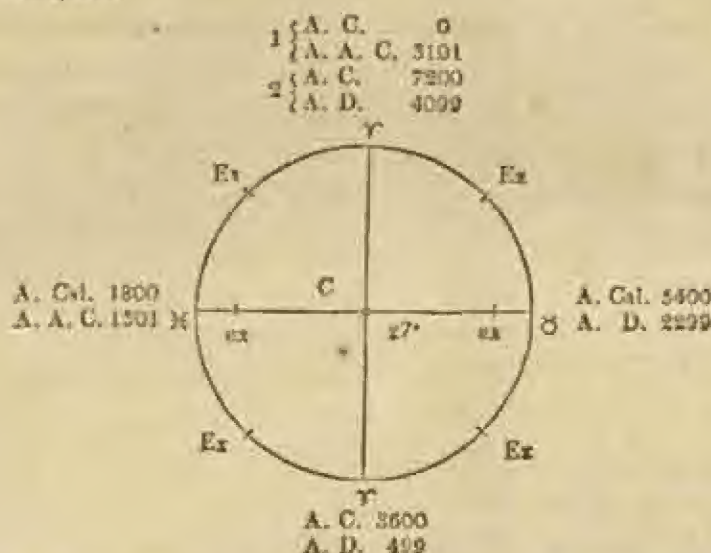
The *Ayanansa*, the principal Element used in this research.

At what precise Epochs these changes have been effected is a question which, for the last five and twenty years, has divided those of our European contemporaries who have cultivated Hindu Astronomy; and as the succession of these changes must have depended on the precessional variation, the motion of the Equinoctial points has given rise to discussions which would have been rendered still more animated, if the Native Sastras had been called upon to take a part in them. With these changes, and their Epochs, I shall have nothing to do. The labour of a man's whole life would probably not suffice to pass a competent decision on such divergent opinions, and no time would remain to apply a final resolution to any useful purpose. It suffices to mine to know, that the most averse to the antiquity of the *Sorriah Siddhanta* admit, that its doctrines have been followed by Indian Chronologists from so early a period as A. D. 539, to the present times; whilst other no less respectable authorities, without going the length of supposing that it was revealed in the 17,27000th year of the *Treta yug*, have thrown that Epoch so far back as A. A. C. 2041, that is to say, 311 years after the universal deluge. But confining ourselves to the most moderate of these computations, it will no doubt be admitted that a system of Chronology which has lasted 1387 years (A. D. 1825), and according to which almost every Kalendar that has been used in India (*), whether Solar, Luni-solar, or Planetary, was constructed, was well worthy of investigation; for its application cannot fail to find materials for consideration, little doubt existing in my mind but that the dates of many considerable events recorded in Indian history lie hid from Europeans, or are much mistaken by them, for want of a competent instrument for unravelling the various Kalendars which have passed through their hands during the last century.

As the problem under consideration depends chiefly on the relative position of the Hindu Syderal and Tropical Ecliptic, the *Ayanansa* or Arc of distance between the Vernal Equinoctial point, and the 1st in the Solar Sign *Mesha* γ , is an Element which, (as it is understood by the

(*) In the country called *Malapala*, extending along the greatest part of the Coast of Malabar between Mangalore and Cape Comorin, the Natives reckon time from the birth of *Parasurama*, which they divide into Cycles of 1000 years. The year of that Epoch begins on the Sun's entrance into the Sign *Carnya* \mathcal{M} , which answers to the month *Aswini*, the sixth in the present order of the Solar months. Dr. Buchanan has calculated that in the month of September A. D. 1800, two complete Cycles had expired since the Epoch, and that the year beginning was the 211th of the third. This computation throws, therefore, the birth of *Parasurama* in A. A. C. 1176. I regret that my ignorance of the existence of that style when I was on the Coast of Malabar, prevented me from enquiring into the particulars of the *Malapala* Kalendar. I believe however, that their circulation is very confined, for in the Northern Provinces of that Coast the Natives chiefly reckon from the birth of *Salivahana*.

modern Hindu Astronomers) must be clearly defined; therefore, although I have already spoken of it at page 84 and other parts of this collection, I shall give here a detailed account of its Phases, without pretending, however, to decide on the grand question whether the original invention of Hindu Astronomy conceived it to librate in an Arc of 27° of the Ecliptic on each side of γ , to revolve in an Epicycle about the same point as a center, or to move round the Platonic Cycle in a period of 24000 years.



If the Ayanantra be considered to revolve in an Epicycle, let each of the Quadrants γK , $\gamma 𑖅$, be supposed to be equal to an Arc of 27° of the Deferent; but if it be supposed to librate from C to $𑖅$, and from C to K, let the radius $C𑖅$, or CK be divided into 27 parts, each equal to 1° of the Ecliptic, and to either supposition what follows will apply.

Phases of the Ayanantra, whether supposed to move in an Epicycle, or to librate on each side of γ to the Hindu Syderal Ecliptic.

Imagine a point Ex in the circumference of the Epicycle, or another ex in its diameter, revolving in one supposition from γ to K, or in the latter from C to K, at the annual rate of $54'$ of a degree, the Indian *Granti-Patagati*, or precessional variation.

Then in the Epicircular hypothesis from the year 0 to 1800 of the Cali yug complete, Ex (and ex in the libratory) will have moved through an Arc equal to 27° of the Deferent or Ecliptic, contrary to the order of the Signs: and as in the first and second Quadrants the Ayanantra is negative, the Tropical Longitude of the Vernal Equinoctial point at the beginning of the year, or (as Europeans would consider it) that of the beginning of the Syderal Zodiac would be $12^\circ - 27' = 11^\circ 3'$, shewing that the Equinoxes were then in 3° of Mīn 𑖅 and of Canya 𑖅.

First Padah or Quadrant.

From this limit, which it is supposed never to exceed, or from the year 1800 to 3600 of the Cali yug complete, the Ayanantra will have decreased until Ex coincided with γ in the lower part of the Epicycle (or ex with C) when it became again equal to zero.

2d Padah or Quadrant.

The Ayanansa positive or negative.

The Longitude of γ is the Supplement of the Ayanansa to 12 Signs when it is negative.

The Longitude of the same is equal to the Ayanansa when the latter is positive.

Third Padah or Quadrant of the Ayanansa.

Fourth Padah or Quadrant.

In the 2d and 3d Quadrants of the Ayanansa the Hindu and European precessional variation may be compared by one single operation.

In the 1st and fourth, it requires two.

The problem under consideration, demonstrated by the result of several Examples.

It is to be observed that during the two first Padahs, or Quadrants, although Ex in the first, moved *contrary* to, and in the second according to the order of the Signs, yet as in both cases it lies West of γ , it is *negative*; therefore the Longitude of the first point of the Syderal Ecciptic, is the *Supplement* of the Ayanansa to 12 Signs . And for the same reason, because in the third and fourth, Ex lies East of the same, moving in the direction of, in the 3d, and *contrary* to, the Signs in the 4th, the Ayanansa becomes *positive* (i. e. from A. Cm. 3600 until 7200), during which interval the Longitude and the Ayanansa are one and the same thing.

It need hardly be added that when Ex, after having passed γ (or ex, C) coincides with δ , which will occur when 5400 years of the Cali yug have expired, then its Ayanansa and Longitude will be $+27^\circ$, shewing that the Equinoctial points will then be in 27° of Vrisha δ , and Vrischika δ ; and lastly, that when 7200 years of the Cali yug have expired, Ex will have regained γ in the superior part of the Epicycle (or ex, C), and therefore the Ayanansa, as well as the Tropical Longitude of the first point in the Syderal Zodiac, will be equal to *zero*.

As the Supplement of the Ayanansa to 12 Signs , in the 2d, and the Ayanansa itself, in the 3d Quadrants of the Epicycle, increase in the same manner as the European precessional variation, the Arc of distance between the first point of the Syderal Ecciptic and the Equinox Ex (i. e. between A. A. C. 1301 and 2299) in the said Padahs, may easily be compared to the Tropical Longitude of the same point, computed by means of the European Tables.

But as in the 1st and 4th Quadrants (i. e. from A. A. C. 3101 to 1301 complete in the *first*, and from A. D. 2299 and 4099 in the *fourth*) the Hindu theory supposes that Ex, or ex returns towards γ or C, with *contrary* Signs; whereas by the European doctrine, these continue to recede therefrom according to the laws of the precessional variation, until Ex or C have reached their greatest elongation in the great scope which they have to describe, the Equation of the Ayanansa to the European Tropical Longitude at either season is of course equal to *nearly* twice the Cranti-Patagati (the motion of the Equinoctial points) due to the number of years elapsed between A. A. C. 3101 and 1301 in the first Quadrant, or between A. D. 2299, and 4099 in the fourth; as shall be shewn hereafter.

From what has been said it follows, that if any document could appear, which should bear as its only distinguishable date, the Sun's place in the Indian Syderal Ecciptic, according to the fictitious system of the Ayanansa, in any year comprised in the said first and fourth Quadrants, another Equation would be required to refer the mean Longitude of Ex (or ex) in the Syderal Zodiac to its true Longitude in the European Tropical Ecciptic.

As this work has principally profited for its object, instead of giving an analytical demonstration of the problems under consideration, I shall disclose the theory on which they rest by a number of Examples, which will present them under every aspect that such questions may assume: and it will be found in the present case, as in every other treated of in this collection, that the

most difficult task imposed on the reader as well as the author, does not arise from the application of deep scientific knowledge, but from the difficulty of exposing briefly, and understanding clearly, methods which have little analogy with those used by European mathematicians.

To find the Tropical Longitude of any point of the Hindu Sydereal Ecliptic, as computed by the Native Astronomers, presents no sort of difficulty: the problem consists merely in the computation of the *Ayanansa* explained at page 86, and rendered still more easy by Table XXXV, and in adding the same if *positive*, or its Supplement to 12 Signs if *negative*, to the proposed Sydereal Longitude in the Ecliptic, if it be occupied by the Sun, or in the Orbit of the Planets if these be considered, referring it however, to their obliquity with the Ecliptic in the latter case. The sum of the *Ayanansa* and *Mudhyama Graha* (mean place in the Sydereal Zodiac) is what the Hindus call the *Sayana* or Tropical Longitude of the Aster when in the proposed point, which they no longer count by the names of the Solar signs *Mesha*, *Vrisha*, *Mithuna*, &c. but by I, II, III, &c. as European Astronomers are in the habit of doing.

But the present question involves one consideration more, namely, how to deduce at once the European Tropical mean Longitude of a point given in the Hindu Sydereal Ecliptic, without any other reference to the Indian Tropical Zodiac than the consideration of the *Ayanansa* at the beginning of the Hindu Solar year when the Sun is in the proposed point of his Orbit.

The operation which forms the subject of this paper depends entirely on an annual Equation of $1^{\circ} 45', 6$ European time ($4^{\circ} 24', 04$ Hindu time = α) amounting in a century to $2^{\circ} 56' 1', 6$ European time ($7^{\circ} 20' 4''$ Hindu time = β) to be applied \pm to the time when, according to the Hindu computation, the Sun occupies the proposed point, as shall be shewn hereafter. But the Longitude deduced from the time so equated is subject to a small reduction, by drawing the same into $\frac{54^{\circ}}{54^{\circ} 1' 15''}$, as it answers to a precessional variation greater by $1^{\circ} 15''$ than $54''$ per annum. (*)

General View of the Proposition.

It was found in the course of this research that the European Tropical Longitude of the Sun, when in a certain point of the Hindu Sydereal Ecliptic which corresponds in time to the 14th December of A. D. 2519, Julian Style (+) at $18^{\circ} 53' 14''$ P. M. under the Meridian of Paris, will be precisely the same as that which would result if computed by the *Ayanansa* due to the beginning of the 5621st year of the Cali yug; plus the Sun's mean motion for $253^{\circ} 7' 18' 54', 6$ ($18^{\circ} 17' 17''$ Hindu time) at Lanka. But it was also found, as stated in the present page, that the

The Hindu Tropical Longitude of any point of the Ecliptic deduced from its position in the Hindu Sydereal Ecliptic, by means of the *Ayanansa*.

As also that of the Planets.

The Hindus count the Signs of their Tropical Ecliptic by their numerals.

Reduction of a point in the Hindu Sydereal to the European Ecliptic, considered.

Elements. Value of α and β .

Reduction of the precessional variation supposed to be $54^{\circ} 1' 15''$ to $54''$.

Epoch when β and $\alpha = 0$.

A. C. 5621, 7th Pancha.

A. D. 2519, 14th December, Julian Style; 26th December, Gregorian Style.

(*) This part of the Equation is subtraction when the Longitude equated by means of β and α , which gives always that which would result of a precessional variation of $54^{\circ} 1' 15''$, is greater than by $54''$, and vice versa: but the multiplication by $\frac{54^{\circ}}{54^{\circ} 1' 15''}$ is dispensed with by help of Table XXXVI.

(+) 26th December, Gregorian Style.

divergence of the European Tropical, and Hindu Sydereal Solar Tables, from that instant of time increases precisely at the rate of $1' 45''$ per annum; it follows therefore, that if this Equation, which I call a , its multiples or fractions, be applied with contrary Signs in ascending and descending years, to the time when the Sun, by the Hindu account, is in the proposed point of the Sydereal Ecliptic, his Longitude answering to the time so equated, drawn into $\frac{365}{365 \cdot 2422}$, will be the same as would result from its being computed with reference to the *Ayananza*, the difference of the proposed Hindu and equated time shewing the error of the Indian Solar Tables.

If therefore, the remoteness of an Epoch (A. D. 2519) which is thrown so far off from our times; and the inconvenience of a broken period of 253 days, &c. from the commencement of the Hindu Solar year, were not a strong objection against its being resorted to, the following general formula would be found to apply to all past and future times.

$$T = g \pm (SnC + ma) \pm dx$$

where g represents the time when the Sun is in the proposed point of the Ecliptic. S = the secular Equation $76' 20''$ Hindu time; SnC = any multiple of the same; a = the annual Equation $4' 24'' 04$ Hindu time; ma = any multiple of the same (*); dx = the correction adverted to in the note at the foot of the preceding page; and T = the equated time sought, which will indicate the error of the Hindu Solar Tables.

The broken period of 19 years, $345' 19' 53' 14''$ referred to the Julian year and Meridian of Paris (preceding page), or of $253' 7' 16' 54'' 6$ referred to the time of the commencement of the Hindu Solar year 5021, may easily be done away, by referring the above formula to the beginning of the century (A. D. 2500), which would then correspond to the 5602^d year of the *Calli yug*; for any

365th (one common year): $4' 24'' 04 :: 16' 253' 16' 17' 17'' :: 1' 26' 40''$, which last term, calling Δ , the new formula for all years ascending from A. C. 5602 (A. D. 2500) will be,

$$T = g + SnC + \Delta + ma \pm dx$$

and it will be found sufficiently accurate for all practical purposes.

But these Epochs are too remote from our times, not to be extremely inconvenient in practice. In the following tract, I have therefore referred the general formula to two different Epochs, viz. to the year of Christ 1700 for ascending, and 1800 for descending Julian years, the intermediate Hindu Solar years which concur with those of the 18th Christian century, being subject to two special formulae, reducible as the others to the general one.

In all cases it is to be understood, that the Julian Kalendar alone is to be referred to in the resolution of problems depending on the Sun's position in the Hindu Sydereal Ecliptic, on account

(*) In case of fractions of years $\frac{a}{365}$ will be found equal to $0p,7122$, the equation for one day, and $12p,2418$ for 1000, from which the fraction for any number of days may easily be deduced.

How to compute the error of the Hindu Solar Tables on which the Kalendar is constructed.

General formula.

In notation.

15th December (the 365th day of the year) answering to 7th Pausin.

Formula for all years ascending from A. C. 5602, A. D. 2500.

Other Epochs preferred, the formula adapted to the same.

The Julian Kalendar alone is to be used in the resolution of questions.

of the 25 Bissextile years of that style in a century (all Secular years being Leap ones) and the invariable regularity of its construction.

The application of the method under consideration supposes a knowledge of the use of the European Solar Tables, which implies no great degree of science, for all that is required of the computer is, that he should know how to find the Sun's mean Longitude for any year, day or instant that may be proposed. (*)

Notation, Formulae, and Examples.

The foregoing introduction seeming sufficient to give a general notion of the nature of an Instrument which I have used with success for the resolution of some very remote and obscure cases, I shall now proceed to shew how it is to be handled, and conclude by shewing its application.

It is to be regretted that the remoteness of the Epoch to which the general formula refers has necessitated the splitting of it, into several special formulae, which give an appearance of complexity to the problem, which in reality it has not, and which has increased the notation beyond the usual measure; but if the reader has the patience of expounding a couple of cases, he will soon find that the process is by no means a delicate one, and that he need not be detained more than a quarter of an hour on any one case that can be proposed.

Instead of presenting the formulae collectively, I have separated them into several propositions, which will render the references easier, and prevent confusion.

Notation.

Let β represent any time according to the Hindu Solar Sydereal Kalendar, where the year consists of $365^{\circ} 15' 31'' 15''$, the Hindu monthly date being previously expounded into its concurring European date according to the Julian Kalendar, (vide Key to the Madhyama Sauramaana), but the fractions of days remaining expressed in guddias, viguddias and paras.

S = The secular Equation $7^{\circ} 20' 4''$ Hindu time ($2^{\circ} 56' 1'', 6$ European time) mentioned at page 240.

nC = Any number of centuries.

a = The annual Equation $4^{\circ} 24'', 04$ Hindu time ($1^{\circ} 45'', 6$ European time) mentioned at the same page.

$\frac{a \times D}{365}$ = The same Equation for any number of days not exceeding one year.

ma = Any number of years not exceeding a century.

(*) As all sorts of Tables are scarce in India, I have compressed Delalande's four 61st Tables (Edition of 1758) into two, and added at the foot directions for using them: these will be found in Table LII, part 1st and 2d.

A = A constant Equation applicable to all years ascending from the 4802d of the Cali yug (A. D. 1700) = $7^{\circ} 12'$ Hindu time ($2^{\circ} 52'$ European time).

B = A constant Equation applicable to all years descending from the 4902d year of the Cali yug (A. D. 1800) = $7^{\circ} 12' 52'$ Hindu time ($2^{\circ} 53' 8'',6$ European time).

E = A constant Equation applicable to all Hindu Solar years from the 4804th to the 4902th year of the Cali yug (A. D. 1702 to 1799) answering to the 97 last years of the Christian 18th century = $1^{\circ} 26'',08$ Hindu time ($24'',2$ European time).

r = An Equation applicable only to the 4803d year of the Cali yug (A. D. 1701) = $2^{\circ} 47'',05$ Hindu time ($1^{\circ} 17'',1$ European time).

Δ = A constant Equation, being one of the terms of the formula which applies the computations referred to the 5602d year of the Cali yug (A. D. 2500) = $1^{\circ} 26' 40''$ Hindu time ($34' 40''$ European time) as stated at page 250.

x = The general multiple $\frac{54^{\circ}}{54^{\circ} 1^{\circ} 15''}$ mentioned at page 249.

dx = A correction which dispenses from using the multiple x , being the difference of the Ayanantas given in Tables XXXV and XXXVI, to be applied \pm , as stated in the note at the foot of page 249.

H = 5 hours (constant).

L = The difference of Longitude in time between Paris and Lanka (constant).

T = The time sought.

N. B.—As H and L are constant quantities, and are applied in the same manner in all cases, they are not considered in the formulae, although they are always used in expounding them.

PROPOSITION I.

" If to the time of the beginning of the 5602^d year of the Cali yug (A. D. 2500) you add the
 " constant quantity $1^{\circ} 26' 40''$ ($34' 40''$) Δ ; and if for any other Solar Sydereal year ascending
 " therefrom, besides the said quantity Δ you add $47^{\circ} 24',04$ ($1^{\circ} 45'',616$ European time) a
 " for each year; and $7^{\circ} 20' 48''$ ($2^{\circ} 56' 1'',6$) S for each century, the Sun's mean Longitude due
 " to the time so equated drawn into $\frac{54^{\circ}}{54^{\circ} 1^{\circ} 15''}$ will be equal to the Ayanansa or its Supplement
 " for the beginning of the said Solar year."

" And the general formula for all years not exceeding the 5602^d of the Cali yug will be

$$T = \beta + (SoC + \Delta + ma) \pm dx (*) \text{ (page 250)}$$

Special formula
for all years ascend-
ing from 5602 Cali,
A. D. 2500, to any
assignable time.

(*) The term dx is the difference of the Ayanantas given by Tables XXXV and XXXVI converted into time by means of Table LII, and dispenses from drawing the Sun's Longitude due to the equated time into $\frac{54^{\circ}}{54^{\circ} 1^{\circ} 15''}$. It is additive when the Ayanansa or its Supplement to 12 Signs (when it is negative) is greater than that given by Table XXXVI, and subtractive when it is less.

where nC represents the number of centuries, and m the number of years between that which is proposed, and the Epoch 5602.

PROPOSITION II.

- " If to the commencement of the 4802^d year of the Call yug (A. D. 1700) you add one day
 " and the constant quantity $7^{\circ} 12' 45''$, (European time) A ; and if besides the said quan-
 " tity, you add for any other year ascending therefrom the value of a for every year, and of S
 " for every century as above noted, the Sun's mean Longitude due to the time so equated drawn
 " into $\frac{54^{\circ}}{54^{\circ} 1' 12''}$ will be equal to the Ayanansa, or its Supplement to 12 Signs if it be negative,
 " for the beginning of the said Solar year.
 " The formula for all years ascending from A. C. 4802 (A. D. 1700) to any Epoch not
 " exceeding A. C. 1500 (A. A. Christ, 1501), will be

Special for all years
ascending from A.
Call 1800, A. D.
1700, to any unques-
tioned time.

Not exceeding A. C.
1800 complete,
A. A. C. 1501.

$$T = \beta + 1^{\text{day}} + (SnC + A + ma) \pm dx$$

" the notation remaining as before.

" The formula for A. C. 4802 (A. D. 1700), is therefore merely

$$T = \beta + 1^{\text{day}} + A - dx.$$

PROPOSITION III.

- " If to the commencement of the 4902^d year of the Call yug (A. D. 1800) you add 1 day,
 " and from the sum you subtract $7^{\circ} 12' 52''$ ($2^{\circ} 53' S^{\circ}$, European time) B ; and if besides the said
 " constant quantity you subtract furthermore the value of a for each year, and of S for each
 " century descending, the Sun's mean Longitude due to the time so equated drawn into
 " $\frac{54^{\circ}}{54^{\circ} 1' 12''}$ will be equal to the Ayanansa for the beginning of the said Solar year.

Special for all years
descending from A.
C. 4902, A. D. 1800.

" The formula for all years descending from A. C. 4902 (A. D. 1800) to any year not
 " exceeding A. C. 5400 (A. D. 2299), will therefore be

$$T = \beta + 1^{\text{day}} - (SnC + B + ma) - dx$$

and for the 4902^d (A. D. 1800)

$$T = \beta + 1 - B - dx.$$

The Hindu Solar years which concur with those of the XVIIIth century, may all be equated by means of the first or general formula,

$$T = \beta + SnC + \Delta + ma - dx;$$

but the same may be done by means of the following special formula.

PROPOSITION IV.

- " If to the commencement of the 4803^d year of the Call yug (A. D. 1701) you add one

Special for the year
of the Call yug 4803,
A. D. 1701 only.

(*) In Blackville years $ma = 0$.

Ayanansa on the beginning of the Hindu Solar Sydereal year 4802 of the Call yug, answering to A. D. 1700, a Bissextile year O. S.

The formula in the present case is (page 253.)

$$T = g + 1 \text{ day} + A = dx. \quad (\text{Proposition II.})$$

Time of commencement of the Solar year 4802 expounded in the usual manner.

$\beta =$ March				n.	r.	p.
+ 1	-	-	-	23	40	40
+ A	-	-	-	1		
Hindu time				24	41	40

The same European time	20	18	42	52
Subtract, to count from noon, H	-	-	-	6
Longitude in time between Paris and Lanca, L	-	-	-	4
Equated time uncorrected,	20	7	18	40

when the Sun's mean Longitude is equal to the Ayanansa such as given in Table XXXVI, and will be found to be $18^{\circ} 1' 12''.9$ which drawn into $\frac{54''}{24^{\circ} 1' 45''} = 18^{\circ} 0' 53''.5$.

In order to save the trouble of the latter operation, say

Table XXXV, Ayanansa A. C. 4802	-	-	18	0	54,0
XXXVI, do. do.	-	-	18	1	19,9
Difference dx					23,9 (*)

and the time which the Sun will take to move through that number

of seconds (Table LII) is $10^{\circ} 31'$, which subtracted from March

Leaves the true equated time T = March	20	7	38	9
--	----	---	----	---

at which time the Sun's mean Longitude (at Paris) will be found equal to the Ayanansa, as may be computed thus :

From 1st January to 29th March 89 days; but as the Sun's mean Longitude for 1700 in Table LII is given for noon 1st January (on account of the Bissextile), take only for 88 days.

☉'s mean Longitude Table LII, 1st January 1700	-	9	20	57	51
For 80 days, part 2d	-	2	18	51	6,4
8 do. do.	-		7	53	5,6
7 hours	-			17	14,0
30 minutes	-			1	13,9
8 minutes	-				1 2,7
9 seconds	-				4
Sun's mean Longitude equal to the Ayanansa	-	0	18	0	52,0

differing only $1''.1$ from that given in Table XXXV.

N. B.—The same calculated by Delalande's Tables gives exactly $18^{\circ} 0' 54''$.

(*) Generally dx is subtractive when the Longitude given by Table XXXVI, is greater than that by Table XXXV, and vice versa.

Example for Hindu Solar years comparing with Christian Secular years O. S.

Call yug 4802, A. D. 1700 secular.

Ayanansa and Longitude of the first point in Meaka Y $18^{\circ} 0' 54''$.

SCOLIUM.

According to the Hindu Kalendar the Sun is supposed to have entered the sign Mesha γ on the 23th March 1700 at $12^{\circ} 40'$ p. m. Meridian of Lanka (1°); but according to European computation, he only entered it on the 29th of the same month at $12^{\circ} 31' 21''$ also at Lanka; i. e. $23^{\circ} 52' 21''$ later: during which time the Sun would move through an Arc of $38^{\circ} 31' 4''$. It follows therefore, that the Hindu Kalendar advances too much the Sun's position, since it assigns it $12^{\circ} 0' 0''$ when it is only $11^{\circ} 29' 1' 8'' 0''$. Hence the correction of the Hindu Tables should be subtractive from the *Ayanansa*, or additive to the time.

		a. m. s.			
1 ^o	To count from noon, subtract	23	46	40	0 from \odot rising.
		— 15			
Hindu time	- - -	23	31	40	0 p. m.
		u. ' "			
European time	- - -	23	14	40	0 p. m.
2 ^o		h. ' "			
Equated time	- - -	29	7	33	9 p. m.
To reduce to Lanka	- - -	+ 4 54 12			
		—			
True time	- - -	29	12	31	21
Time as above	- - -	23	14	40	0
		—			
Error in time	- - -	0	23	52	21

EXAMPLE II.

Let the time be proposed for the beginning of the 4002d year of the Call yug, answering to A. D. 1800, being (according to the Julian Kalendar) a Bissextile year: (*)

The formula is $T' = \beta + 1 - B - dx$ (Proposition III).

Ayanansa.	.	.	.	.
By Table XXXV, 19	30	54	0	
do. XXXVI, 10	21	21	6	
	—			
Difference	27	6		
Answering to $11^{\circ} 0'$ of time = dx.				

$\beta =$	Merch	29	38	45	0
+ 1	.	1			
		—			
— B	.	30	23	45	0
		—			
In Hindu time		30	31	52	8
		—			
In European time		30	12	36	51 from \odot rising.
Subtract, to count from noon, — H	.	— 6			
		—			
Longitude in time between Paris and Lanka — L	.	30	6	26	51 p. m.
		—			
		4	54	12	
		—			
— dx	.	30	1	41	39
		—			
		11	0		

Equated time, Meridian of Paris, $T = 30 \ 1 \ 31 \ 39$ p. m.

(*) Not to repeat entirely the same words, the time of commencement of the Hindu Solar Sydercal year, represented by β , will be supposed known. (Vide 1st Memoir.)

Call yug 4002, A. D.
1800 Secular.

Ayanansa and Longitude of γ $12^{\circ} 30' 54''$.

SCHOLIUM.

By the Hindu Calendar, the Sun is supposed to have entered the sign Mesha γ on the 13th March A. D. 0, at 18° 30' p. m. at Lanka (1st), and the Sun's Longitude in the Tropical Ecliptic was 11° 22' 30' 54" on the 13th of the same month at 20° 22' 40" p. m. also at Lanka, by the European Tables (2^o). The difference in time is therefore 3^h 2^m 0^s 14", during which the Sun would move through 3° 2' 21" (Table III, part 2), and as the Hindu Calendar supposed the Sun to have 12° Longitude, *three days, &c. before* he was actually thus much advanced in the Ecliptic, it follows that the error of the Hindu Tables is *subtractive* of the Longitude and consequently *additive* to the *Ayanansa*, as well as to the time registered in the Calendar.

EXAMPLE IV.

Calleg 2102, A. D.
2000 secular.

The same for the commencement of the 5102^d year of the Cali yug, answering to A. D. 2000, a Bisextile year.

The formula is $T = \beta + 1 \text{ day} - (\text{SoC} + B) - dx$. (Prop. III.)

OPERATION.

2000	nC = 2	B = 7° 20' 4"
1800		
(2000)		
Ayanansa.		
Table XXXV,	22° 30' 54"	
do. XXXVI,	22 31 25,2	
Difference	31,2	
The time, due to which is 12° 15' = dx.		
S = 7° 20' 4"		
× 2		
	14 40 8	
+ B.	7 12 22	
SoC + B =	21 23 0	

$\beta =$	March 21 22 55 0	
+ 1 day	+ 1	
	April 1 22 55 0	
— SoC + B	— 21 23 0	
Hindu time, April	1 1 2 0	
European time	1 0 24 48	
— II	— 6	
	March 31 18 24 48	p. m.
— I.	— 4 54 12	
	31 13 30 36	
— dx	— 12 15	

Equated time at Paris, T = March 31 13 18 21 p. m.

and whether we resolve the Sun's mean Longitude by Delalande's Tables, or by Table III, we shall find it to be 22° 30' 54", differing from the *Ayanansa* (which is also the Longitude of the 1st point in Mesha) by 6",

The error of the Calendar may be deduced in the same manner as before,

Ayanansa and Longitude 22° 30' 54".

☉'s mean Longitude 1st January 1800, Table LII,	-	2 21 43 47
Part 1st, do. for 10 years	-	7 10,9
Part 2d, for 20 days, 4 hours, 23 minutes, 21 seconds	-	2 27 54 10,8
☉'s mean Longitude at equated time	-	0 19 45 18,1

differing only 0',1 from the Ayanansa.

The foregoing six Examples provide for every case of Hindu Solar Sydercal years corresponding to Christian years which are either Secular or Bissextiles. As for the common years the rule is the same, observing that in *ascending* years from A. D. 1700, the term m of the first formula, applies to the number of years counted from the end of the century giving the years which are wanting to complete H ; and m of the second, to the number of years counted from the beginning of A. D. 1800 to the proposed one. I shall give a few Examples of the case of Hindu Solar corresponding to common European years, for the purpose of shewing how the Sun's mean Longitude according to European Astronomy, is to be computed by means of Table LII. (*)

SECTION III.

Examples for Hindu Solar years which correspond with common Christian years before and

Example for a year
before Christ.

A. C. 2101.
A. A. C. 1.
B. C. and common.

EXAMPLE VII.

Let it be proposed to equate the commencement of the 2102d year of the Cali yug, answering to A. A. C. 1 current, a common year.

It will be found by Table VIII (page 10 of the Tables), that the Initial Root for that year is Friday, at 45° 43' 45" after Sun rise; and by Table V, part 2d, that this Friday falls on the 14th March, which gives the value of β in the formula $T = \beta + 1 + (SnC + A + m) + dx$ (Prop. II).

OPERATION.

Ayanansa, 2
7 50 0
12 9 0 0
Long. 11 23 20 0

1700
+ 1 nC=17. m=1 m=4' 24",04.
(17) 01
S 7 50 4
× 17
SnC 2' 4 41 8
+ A 7 12
m 4 24
= 4 53 44
SnC + A + m

Longitude deduced from Ayanansa.

Table XXXV, 11 22 30 0 0
do. XXXVI, 11 22 29 40 35
Difference + 10 25

Answering to 4' 12" in time = dx.

6. 7. 8.
β March 15 45 43 45
+ 1 day + 1
+ SnC + A + m 2 4 53 44
Hindu time 17 50 26 29
European time 17 20 14 30 from ☉ rising
— II — 0
17 14 14 35 p. m.
— I — 4 24 12
17 9 20 23
+ dx 4 12

Equated time, Meridian of Paris, T = March 17 9 24 35 p. m.

(*) The author begs here to remind the reader, that he is not writing for the purpose of instructing Astronomers, but merely to give to those who are not, the means of using his Tables and Formulae.

which rule differs in no respect from the preceding; but in order to find the Sun's mean Longitude by means of Table LII, which is the same as that deduced from the Ayanansa, we are to proceed as follows:

Part 1, ☉'s mean Longitude 1st January, div. 1,	9	7	57	5
☉'s motion for one year ascending, div. 4,			44	48,8
☉'s mean Longitude 31st December A. D. 0,	9	7	12	10,2
And there being from that date to March 17th, 76 days, we have by part 2 (out of the respective divisions) for 76° 2' 24' 36"	2	15	17	44,3
☉'s mean Longitude sought,	11	22	30	0,5

which differs only from that deduced from the Ayanansa by 0',5.

EXAMPLE VIII.

The same for the commencement of the 4743d year of the Cali yug, corresponding to A. D. 1641, a common year.

A. C. 4743, A. D.
1641 common.

Formula $T = 8 + 1 + (SoC + A + ma) - dx$ (Prop. II.)

OPERATION.

Ayanansa and Longitude. As this case offers nothing new, I shall be contented with stating that $SoC = 0$; $m = 50$; $ma = 4^{\circ} 10' 33''$; $SoC + A + ma = 4^{\circ} 25' 50''$; $dx = 9' 34''$; and ε , by the usual process, being found to answer to March 28th, 30' 56' 16", the time after noon equated to the Meridian of Paris is March 26th, 3' 5' 28", at which time the Sun's true Longitude by Delalande's Tables, or Table LII, will be found as follows:

Ayanansa and Longitude 37° 7' 48".

Table LII, part 1st, div. 1, ☉'s mean Longitude 1st January 1600	9	20	11	50
Do. do. div. 3, for 40 years			18	22,26
Do. do. div. 4, for descending years, one year	11	22	43	40,5
☉'s mean Longitude 31st December 1640	9	20	15	53,76
Part 2, (by the respective divisions) for 82° 3' 5' 28"	2	26	51	49,96
☉'s Longitude, differing 0',7 from the Ayanansa,	0	17	7	42,72

SECTION IV.

On the manner of equating the beginning of Hindu Solar years concurring with those of the XVIIIth Christian century.

How to equate the beginning of Solar years concurring with those of the 18th Christian century.

We have already observed (page 233) that the term A of the first formula ($7^{\circ} 12'$) applies to Solar years concurring with all Christian years ascending from A. D. 1700; and that B, of the second formula ($7^{\circ} 12' 52''$) to those corresponding to all Christian years descending from A. D. 1800. We are now to consider the resolution of that part of the problem, which equates the commencement of Sydercal years from the 4802^d to the 4902^d of the Cali yug, corresponding with

those of the European XVIIIth century; the mode of doing which differs only in appearance from the rest, for every thing still depends on the Secular Equation $S = 7^{\circ} 20' 4''$ and its fractions. The formula however, changes, as we have seen at page 254, and this is to be ascribed to the Signs passing from + to — during that interval, although if we were to begin from that Epoch where $S, A,$ and $B = 0$, such a change would not occur, as shall be seen hereafter.

N. B.—It is to be remembered, that A is only equal to $7^{\circ} 12''$; and B to $7^{\circ} 12' 52''$ at the end of the 4801st and 4901st of the Cali yug. The passage from A to B will be explained in what follows:

If from A , due to A. C. 4801 complete	-	$+ 7$	12
We subtract a	-	$- 4$	$24,04$
We have the Equation for 4802 complete	-	$+ 2$	$47,96$
The difference of which to a	-	4	$24,04$
Will be	-	$- 1$	$36,08$

which is the Equation for 4803 complete, answering to A. D. 1702; from which year the Equation becomes negative. I shall therefore call the year 4804 *current* of the Cali yug, answering to A. D. 1702, the Epoch of the years concurring with those of the XVIIIth century, and its Equation $E = - 1^{\circ} 36,08$; that for the beginning of A. Cal. 4803 (1701) remaining peculiar to itself, viz. $+ 2^{\circ} 47,96 = Y$. (Proposition IV).

The above considerations will lead us to determine the value of B for the Solar year concurring with A. D. 1800; for let us find the Equation for the commencement of the 4901st year of the Cali yug, answering to A. D. 1799.

	From the proposed year	-	1799
	Subtract Epoch	-	1702
	Interval	-	97 years = m.
Now multiply $a (4^{\circ} 24,04)$	-	-	$4^{\circ} 24,04$
		by m =	$\times 97$
			$7^{\circ} 6^{\circ} 31,88$
Add E (above found)	-	-	$+ 1^{\circ} 36,08$
Equation for 1799	-	-	$7^{\circ} 8^{\circ} 27,96$
To which add again a for one year	-	-	$+ 4^{\circ} 24,04$
Equation B , for 1800	-	-	$7^{\circ} 12^{\circ} 52,0$

This being understood, so will the formula

$T = \beta + 1 - (E + ma) - dx$. (Proposition V), for all the years of the Hindu account which concur with those of the XVIIIth century, except the 4803d of the Cali yug (1701), which retains its own Equation $+ 2^{\circ} 47,96 = Y$.

SECTION V.

EXAMPLE IX.

We shall first resolve the case of the beginning of the 4803d year of the Cali yug, answering to A. D. 1701, which, as already stated, is unique of its kind, the Equation being

$$T = \beta + 1 + Y - dx. \text{ (Proposition IV.)}$$

Cali yug 4804, A. D. 1702, Epoch for the Solar years concurring with those of the XVIIIth century.

The Equation for 4803 unique.

The values of E and Y referred to that of B in the 2d formula.

Formula for Solar years from 4804 to 4902.

Case unique. A. C. 4803, A. D. 1701.

Ayanansa and Longitude.

Table XXXV, 18 1 48

do. XXXVI, 18 2 13,0

Difference 25,0

Answering to 10' 31" = dx.

$\beta =$	March 29	G. V. P.
+ 1	+ 1	2 11 15
+ 2	+ 0	0 0 2 47,00
		<hr/> 30 2 14 2,00
- H		30 0 53 37,2 from \odot rising.
		<hr/> 0
- L		29 18 53 37,2 p. m.
		<hr/> 4 54 12
- dx		29 13 59 25,2
		<hr/> 10 31
		29 13 49 51,2 p. m.

Time P. M. equated to Meridian of Paris, T'

And for the \odot 's Longitude due to that instant according to the European Tables, we have

Longitude and Ayanansa 19° 1' 48"

Table LII, part 1, \odot 's mean Longitude 1st January 1700	S. . . .
For one year, division 4,	- 9 20 57 51
	+ 11 29 43 40,5
\odot 's mean Longitude 31st December 1699	- 9 20 43 31,5
Same Table, part 2, for 38° 13' 49" 54"	- 2 27 18 18,1
\odot 's mean Longitude sought	- 0 18 1 49,6

differing from the Ayanansa on the beginning of A. Cm. 4803, by 1',6, which is the maximum of deviation which has occurred in the course of this research, even for the remotest times, between the results of the formula, and those of the European Solar Tables.

EXAMPLE X.

The same for the commencement of the 4804th year of the Cali yug, concurring with A. D. 1702.

Formula $T = \beta + 1 - (E + ma) - dx$ (Prop. V.)Here, as the proposed year is that of the Epoch (page 262) m and $ma = 0$, and $E + ma = 1' 35',08$.

Cares for the remaining years of the century.

A. C. 4804, A. D. 1702, a common year.

Ayanansa and Longitude. . . .

Table XXXV, 18 2 42 0

do. XXXVI, 18 3 7 3

- 25 3

Answering to 10' 10" of time = dx.

$\beta =$	March 29	G. V. P.
+ 1 day	+ 1	30 17 42 30
- E + ma		1 35,08
Hindu time, March		30 17 40 55,0
European time		30 7 4' 20"
- H		0 5
- L		30 1 4 20 p. m.
		<hr/> 4 54 12
- dx		29 20 10 10
		<hr/> 10 10

Ayanansa and Longitude 15° 2' 42"

Equated time, Meridian of Paris, T = 29 20 0 0 p. m.

And for the European Tropical mean Longitude.

By Table LII, ☉'s mean Longitude 1st January 1700,	s.	'	"	'
For 2 years, do. dis. 4,	9	20	57	51
	11	29	31	21
☉'s mean Longitude 31st December 1699	9	20	29	12
And by part 2, for 88 days, 20 hours,	2	27	33	29,9
☉'s mean Longitude sought	0	18	2	41,9

differing only 0',1 from the Ayanansa.

EXAMPLE XI.

A. C. 4550, A. D. 1748.

The same for the 4860th year of the Cali yug (A. D. 1743).

Ayanansa and Longitude 18° 44' 6" a Biscutle year.

The formula being the same in all such cases, we have $m = 46$; $ma = 46 \times 45' 24",04 =$

$3\text{h } 22^{\text{m}} 25^{\text{s}},8$; and $E + ma = 3\text{h } 24^{\text{m}} 10^{\text{s}},33$. Hence

1748 Ayanansa and Longitude.

1703 Table XXXV, 18° 44' 6"

do. XXXVI, 18 44 32

46 = m.

and the time answering to 26' is $10' 25" = dx$.

$\beta =$ March 29 11 40 0
+ 1 - + 1

— E + ma . 30 11 40 0
— 3 34 2

Equated Hindu time 30 8 15 58

do. European time 30 3' 18' 25'

— H . — 6

— L . 29 21 18 23 p. m.
— 4 54 12

— dx . 29 16 24 11 p. m.
— 10 55

Equated time, Meridian of Paris, T = March 29 16 13 36

and the ☉'s mean Longitude for that time by Table LII, will be found 18° 44' 6",8.

The eleven preceding Examples provide for every possible case that can be proposed for any time past or to come; but there remains to show the derivation of the various formulæ hitherto used, from the general one given at page 250, and this will be done by means of three Propositions, which are only introduced here for the sake of demonstration, their object being to trace the time when the terms S and a of the formulæ become equal to zero.

SECTION VI.

PROPOSITION A.

The Equation for the beginning of A. C. 5002 is $1\text{h } 26^{\text{m}} 40^{\text{s}} = \Delta$. A. D. 2500 the Epoch referred to.

" If to the time of the beginning of the 5002d year of the Cali yug, answering to A. D. 2500,

" you add $1^{\text{h}} 26' 40''$ ($34^{\text{h}} 40'$ European time) = Δ , and reduce the same to noon under the

" Meridian of Paris, the Sun's Longitude due to that instant, as given by the European Tables,

" will be equal to the Ayanansa for that year as computed by the Hindu rule." (Proposition I.)

PROOF.

The beginning of A. C. 5602 as elicited by the rule given at page 8 of this collection, falls on Wednesday at 43^h 20^m 0^s after Sun rise at Lanka, and for the monthly date of the initial feria, we have by Tables V and VI, parts 1, Wednesday, 4th April, Julian style, therefore

Formula $T = \beta + \text{SuC} + \Delta + \text{ma} - \text{dx}$, where $\text{SuC} = 0$; $\text{ma} = 0$.

A. C. 5602, A. D.
2500.

Ayanansa and Longitude.

	s.	'	"	"
Table XXXV,	1	0	0	54 0
do. XXXVI,	1	0	1	35 41

	d.	h.	m.	s.
$\beta =$ April	4	43	20	0
$\Delta =$		+	1	26 40

Difference — 41 41 41',6
Answering to 16' 52" in time = dx.

	d.	h.	m.	s.
Hindu time	4	44	46	40
— H		4	17	54 40 from ☉ rising.
		—	6	
— L		4	11	54 40 p. m.
		—	4	54 12
		4	7	0 28
		—	16	53

Time equated to Meridian of Paris, $T =$ April 4 6 43 35 p. m.

For the Sun's mean Longitude according to the European Tables, we have (the year being a leap one), Longitude and Ayanansa 1st Jan. 0° 0' 54"

Table LII, ☉'s mean Longitude 1 st January 2000	s.	'	"
do. for 500 years	9	23	13 38
		2	40 38,3

☉'s mean Longitude 1 st January A. D. 2500	s.	'	"
By the same Table, part 2, for 94° 0' 43' 35"	9	27	4 16,3
	3	2	55 37,5

☉'s mean Longitude equal to Ayanansa	s.	'	"
	1	0	0 53,8

differing only by 0',2 from that produced by the Hindu rule.

PROPOSITION B.

" If to the foregoing constant Equation $12\ 26^h\ 40^m = \Delta$, you add the value of S ($7^h\ 20^m\ 4^s$) for each century ascending from A. C. 5602, and to the sum you add the time of commencement of the current Tamul year, the Sun's Longitude due to the time so equated will be equal to the Ayanansa." (Proposition I.)

PROOF.

Let the commencement of the 5102nd year of the Cali yug, answering to the Julian Secular year 2000, be proposed. Then by the present Proposition,

EXAMPLE XII.

Let the 4304th year of the Call yug (A. D. 1702) be proposed.

A. C. 1804, A. D.
1702.

$$\begin{array}{r} 2500 \\ 1702 \\ \hline (7)98 \end{array} \quad \begin{array}{l} \text{Then } nC = 7. \quad m = 98. \quad ScC = 7^2 20' 4'' \times 7 = 518' 20'' 28''' \text{, and } ma = \\ 98 \times 4' 24'', 04, = 71' 11'' 16''' 2. \end{array}$$

Therefore

	n.	v.	p.
ScC =	51	20	28
Δ =	1	26	40
ma =	7	11	16,0
ScC + Δ + ma =	59	58	23,0

which is the same Equation as that which was used at Example XI, page 264, and therefore the rest of the operation need not be performed.

Lastly, we are to determine the precise time when S and a will become $= 0$, on which occasion we shall observe, that as this Epoch probably falls on a broken period of the year to which it refers, the term a , which is the variation for one whole year, will exceed that which may be due to the commencement of the Solar year in the course of which it vanishes; a must therefore be transformed into $\frac{a \times D}{365}$, where D represents any number of odd days expired of the year.

Transformation of a
for broken periods
of years into $\frac{a \times D}{365}$.

PROPOSITION C.

The precise time when S and a are equal to 0, falls on the 13th December A. D. 2510, Julian style, (20th Gregorian style), at 13° 53' 14" p. m. under the Meridian of Paris, or 2534 18s 17p after the commencement of the Hindu Solar year 5602 of the Call yug, at Lanka.

Resolution of the
Epoch when S and
 $a = 0$.

As the value of m at the beginning of the Solar year 5602 (A. D. 2500) was found to be 1s 26' 40p, the time when it will be equal to zero is determined by this expression $\frac{1s 26' 40p}{4' 24p, 04} = 19 \text{ years}$, 2534 18s 17p 17p, and as we have now only a fraction of a on the beginning of the Hindu year, the formula will become $T = \beta + \frac{a \times D}{365} - dx$, where $D = 253$ days in the present case, to expound which we have by Tables VII and I,

Special formula
where $\frac{a \times D}{365}$ is
position.

Initial root for the year C. 5602
which accounts for 19 years. And for the fraction 2534 18s 17p 17p, the Supplementary Table LII, part 2, shews that there are 246 days expired at the end of Margashira; taking therefore the collective root for the said time out of Table III, we have

n.	v.	p.
(5)	39	13 45

Initial root of the month Poushika
To which add root for 7d 18s 17p 17p

(*)	(1)	19	37	10
(0)		56	50	55
(+)	(0)	18	17	17
(1)		13	8	12

Monday.

Margashira. 253
Table LII. 246
Poushika. 719

Root at the given instant

which feria being expounded by means of the Dominical Letter E, Julian style, (Tables V and VI) will be found to fall on the 15th December A. D. 2519.

Here it is to be observed that we have added to the commencement of the	s.	°.	'.	''.
Hindu Solar years, the two following fractions of roots, viz.	(*)	18	37	10
	(†)	18	17	17
Sum, Hindu time	20	54	27	
do. European time	14° 45' 47'' (†)			

during which time the Sun's mean motion amounts to $36^{\circ} 21', 7''$ (†) which are to be taken into the account when we compute the Sun's place by means of the Ayananta; which by

Table XXXV =	s.	°.	'.	''.
XXXVI =	1	0	18	0
	1	0	18	32

Difference 42 answering to $7^{\circ} 4''$ of time = dx.

As for $\frac{s.D}{365}$ we have $365^d : 4^{\circ} 24', 01'' :: 253^d$ (by Prop.) : $3^{\circ} 3p$.

OPERATION.

$\frac{s.D}{365}$ = December 15	s.	°.	'.	''.
$\frac{s \times D}{365}$ (253d)	+	3	3	
Equated Hindu time	15	15	11	5
do. European time	15	6°	4'	30'' ☉ rising.
— H —	—	6		
— L —	15	0	4	30 p. m.
	—	4	34	12
— dx —	14	19	10	18
	—	—	17	4
Equated time, Meridian of Paris, T =	14	18	53	14 p. m.

For the Sun's mean Tropical Longitude.

By the European and Hindu Solar Tables.

Ayananta.	s.	°.	'.	''.	Table LII.	s.	°.	'.	''.
1st Vaisakha A. C. 5521,	1	0	18	0	Sun's mean Longitude 31st Dec. 2519,	9	26	29	58,7
200 days, Table LII,	6	17	7	46	do. 548' or 14th December 2519	11	13	0	18,0
50 do.	1	19	16	56,6	18 hours	—	—	—	44 21,2
3 do.	2	57	25,0		53 minutes	—	—	—	2 10,6
do. for $14^{\circ} 45' 47''$ (†)	36	21,7			14 seconds	—	—	—	0
Sun's mean place	9	16	16	29,2					9 16 16 29,1

The difference of which results is insensible.

There remains now only to show, that S and a will change Signs from the 14th December 2519 Julian style, which will be proved by the following results.

Let the beginning of the 5622d year of the Cali yug (A. D. 2522 a *Bissextile*) be equated.

The formula will be $T = \beta - \frac{a \times D}{365} - dx$, where D represents the number of days that remained from the 14th December 2519 to the end of the Hindu Solar year 5621, for which observing that this expression in the last Example was

$$\begin{array}{rcl} \text{If you subtract the same from a} & - & \frac{a \times D}{365} = 3 \text{ } 3 \\ \text{You have } \frac{a \times D}{365} (1184) & - & = 4 \text{ } 24,04 \\ & & \text{its value for the present case} = 1 \text{ } 21,04 \end{array}$$

Ayanansa, 1st Vaisâcha, Cali yug

5622.	n.	.	.	.
Table XXXV,	1	0	18	54
do. XXXVI,	1	0	19	36

Difference 42, dx therefore remains as before = 17' 4".

OPERATION.

Initial root, preceding Example.

1st Vaisâcha, A. C. 5621	-	-	-	n.	a.	r.	p.
Add for one year, Table I,	-	-	-	(6)	38	15	45
Initial root, 1st Vaisâcha, A. C. 5622	-	-	-	(1)	15	31	15
	-	-	-	(0)	53	45	0

Sunday.

which expounded in the usual manner with the Dominical Letters DC, shows that the initial feria Sunday, falls on the 4th of April 2520 Julian style. Therefore

8 = April	4	53	45	0
$-\frac{a \times D}{365} =$	-	-	-	1 21
Hindu time	4	53	43	39
European time	4	21	29	27,6 @ rising.
- H	-	-	6	
- L	-	4	15	29 27,6 p. m.
	-	-	4	54 12
- dx	-	4	10	35 15,6
	-	-	-	17 4
Equated time, Meridian of Paris, T = April	4	10	18	11,6 p. m.

And for the Sun's mean Longitude at the equated time by the European Tables.

☉'s mean Longitude 1st January A. D. 2520	-	-	-	n.	.	.	.
☉'s motion for 94 days (on account of Bissextile) or 4th April	-	-	-	9	27	14	27,4
by Delalande's Tables,	-	-	-	3	2	39	3
10 hours	-	-	-	-	-	-	-
18 minutes	-	-	-	-	-	24	38,5
11 seconds	-	-	-	-	-	-	44,4
	-	-	-	-	-	-	4
Sun's mean Longitude on the beginning of A. C. 5622	=	1	0	18	53,7		

which differs only by 6",3 from the Ayanansa due to that instant.

Epoch when S and a change Signs.

A. C. 5622, A. D. 2520.

Special formula where $\frac{a \times D}{365}$ is positive.

Ayanansa and Long. grade 12, 0° 18' 54".

Thus we have proved by the result of many operations, the correctness of the formula $T = g \pm (SoC + m \pm) \pm dx$, given at page 250. An analytical demonstration of the same would no doubt have been more scientific; but it was observed by a learned Gentleman, to whose judgment this paper was submitted, that as the *Kala Sankalita* was principally intended for the instruction and use of persons little versed in the higher branches of the Mathematics, Examples were the best mode of demonstration; and to his opinion we have submitted our own. There remains now to shew the application of our formula to the resolution of questions, which depend on the Sun's position in the Hindu Sydereal Ecliptic, at a given instant of time, which to resolve by other means would involve the computer into long and delicate calculations.

FIRST CASE. (*)

Vestiges of the date of an old Inscription expounded.

A. C. 3644 under the government of N. Sun's apparent Sydereal Longitude $33^{\circ} 4' 29'' 47''$.

On an old Inscription much defaced by time, there remains no other vestiges of the date of the event which it was designed to commemorate, but that of the current year 3644 of the Cali yug, with the name of the year of Jupiter's cycle corresponding thereto, viz. *Caloyucta* (the 52d), both answering to the 405th year Saca, or from the birth of Salivahana, and the name of the Prince N, who reigned at that time; and lastly, the Sun's apparent Longitude in the Hindu Sydereal Ecliptic on the day of the event, which is stated to have then been in $4^{\circ} 29' 47''$ of the Solar Sign *Vishchika* M .—Q. What was the Hindu Solar Sydereal date answering to that position of the Sun, and also the concurrent European date?

As the Sun's Longitude recorded on all public monuments is generally his apparent one, the first operation consists in deducing the *mean* from the apparent Sydereal Longitude proposed, being that to which the formula answer; and this is to be effected by means of several of the Tables contained in this collection, and by the following process.

The Christian year is expounded in the usual manner, $3644 - 3102 = 542$ Julian Kalendar, and as the Sign *Vishchika* M is the 8th of the Solar Sydereal Ecliptic, our Longitude is to be expressed $7^{\circ} 4' 29'' 47''$.

To deduct the Sun's mean from his apparent Longitude.

In order to deduce approximatively the Sun's mean from his apparent Longitude, we shall first use the latter as if it were his mean place for finding the corresponding Anomalistic Equation, which will be done by means of Tables XXII or XXIV, and XXVII, part 2d.

As the latter Table supposes the Sun's Apogee in $2^{\circ} 17' 17'' 20''$, which will be its place at the end of the 4010th year of the Cali yug, and as we want it for the 3645th, we are to correct the Apogee for 1207 years, for which (its motion being $1'$ in 517 years), say $517' : 60' :: 1207' : 2^{\circ} 30'$ the Equation sought: which being additive in the 1st and 3d Quadrants, and subtractive in the 2d and 4th Quadrants of Anomaly (agreeably to the construction of Table XXVII), is in the present case to be subtracted.

(*) The date of the Inscription is assumed.

Now the Sign *Vriśchika* answers to the Solar month *Margasirā* (Tamul

Cartiga), on the first day of which the Sun's distance from his Perigee

is (Table XXVII, part 2)

Subtract correction

Distance from do. 1st *Margasirā*

s.	°	'	"
1	17	17	20
		— 2	33
1	17	14	20

But as by the Inscription the Sun was advanced $4^{\circ} 29' 47''$ in the Sign *Vriśchika* III, and because he is advancing towards his Perigee, that Arc is to be subtracted from

the above

Sun's distance from Perigee, called *Manda Kendra*

s.	°	'	"
1	17	14	50
		— 4	29 47
1	12	49	3

The Argument of the Sun's Anomaly.

which is the Argument of his Equation; therefore, with $1^{\circ} 12' 45' 3''$ referring to either Tables XXII or XXIV, we find the same to be $1^{\circ} 29' 20''$; and because in Table XXVII, the negative Sign (—) is affixed to the month *Margasirā* when the apparent Longitude is sought, it is to be added in the contrary case. Hence

Proposed apparent Longitude

Ravi Phala

☉'s approximate mean place

s.	°	'	"
7	4	20	47
+	1	29	20
7	5	59	8

Sun's mean Sydercal Longitude *7h. 5^m 29^s*

With which in such matters, one might very well be contented: but if more accuracy were required, as this mean Longitude would give an apparent one $2^{\circ} 34'$ too great; on a second trial, which need not be exhibited, the exact mean Longitude sought would be found to be $7^{\circ} 5' 56' 37''$.

In order to simplify what remains to be shown in this Example, I shall suppose that the mean Longitude deduced from the apparent one was in round numbers $7^{\circ} 6'$, which is of no consequence, since the difference in the Sun's motion falls considerably below an entire day.

If we compute the Ayananta due to the commencement of the 3644th year of the Cali yug, either by the rule exhibited at page 84, or by Table XXXV, it will be found

☉'s *Madhyama Graha*, as above

Madhyama Ravi Sayana

=	38	42
7	6	0 0
7	6	38 42

Sun's mean Sydercal Longitude assumed *7h. 6^m*

Ayananta $+ 38^{\circ} 42'$
Sun's Hindu mean Tropical Longitude *7h. 6^m 38^s 42^s*

or mean Hindu Tropical Longitude, deduced from Proposition, the error of which we are to calculate before we can determine the European date of the recorded event.

For the time of commencement of the 3644th year of the Cali yug.

By Table VII, Epoch A. D. 500

Table I, for 49 years

Do. 2 do.

s.	°	'	"
(0)	27	11	15
(1)	20	50	0
(1)	15	31	15

Initial root sought

(3)	13	22	30
-----	----	----	----

Roots date Wednesday.

The beginning of the Hindu Solar year expended into its corresponding European date.

the Hindu Tables make his Tropical Longitude too great, as well as the Ayanansa, at the beginning of the year.

From this it results that if from the Hindu Tropical Longitude	s. ° ' "
found at page 271	7 6 38 42,0
We subtract the error	2 22 57,5
We have the corrected Longitude	7 4 15 44,5

Corrected Tropical Longitude is 4° 15' 44",5.

Expounded by the Tables the time due thereto, viz: 31st	s. ° ' "
December 31st	9 11 36 26,2
	9 21 45 5,7 October 23d.
	51 12,6 22 hours.
	7 4 15 44,5

we have for the true date the 23d October 22° 0' 0".

N. B.—We would have obtained the same result if after having expounded the Hindu Tropical Longitude by the Tables, which would have given October	26 8° 0' 55"	True European date Meridian of Paris October 23d, 24h.
We had subtracted therefrom the error in time	2 10 0 35	
For there remains the same time as before found, October	23 22 0 0	True time.

Now this time referred to the Meridian of Lanka, and to that of Sun rising, expressed in Hindu guddias, &c. is

October 23 22° 0' 0" p. m. Paris.
H . 6
L . 4 54 12
European time . 24 8 54 12 from ☉ rising.

True date expressed in Indian guddias, &c. October 21 22 15 30 at Lanka.

For the Hindu Solar monthly date.

Lastly, as the 1st Vaisâcha A. C. 3644, fell on the 19th March 542 (page 272) we have from that date to the 24th October

But by the subsidiary Table LII, part 2, from the 1st Vaisâcha to the last day in

Cartica there are

There remains in the following month

which are the number of days expired in Mârgasîras. The current Hindu Solar date is therefore Mârgasîras 4th, at 22° 15' 30" after Sunrise at Lanka. (*)

For the Hindu Solar monthly date,

4th Mârgasîras current.

(*) Although I have endeavoured to render this Example as clear as possible, yet as from the novelty of the process, a proof may be required that the result is exact, I shall expound by the usual formula the date now

To restore a lost Epoch.

The name of the year of Jupiter's Cycle being given, how to expound the numeral of the corresponding one of the Cali yug.

In Bengal they follow the latter account; in the Peninsula, that of the Tellingas.

The reign of the Prince, whose name is recorded in any document affords data for the time when known in history.

Or that of any of his known contemporaries.

When the duration of any reign exceeds 60 years, the question is subject to two answers.

If it so happens that the numeral of the year of the Cali yug 3544, be also obliterated, so that there only remains the name of Jupiter's year, *Calayuta* the 52d of the Cycle of 60 years, we are to enquire how the Epoch may be restored, and for this we are to attend to the following considerations.

The first point to be ascertained is in what part of India the inscription was found; for if in Bengal, the Chacra year will have been computed by the rule of the Sarriah-Siddhanta, modified by the Tika; and if in the Peninsula, by that of the Tellingas. In the present case we shall suppose that the inscription was found in Bengal.

We are now to observe that as there is a year of the same name in every Cycle of 60 years, the problem cannot be resolved unless some new data be furnished; but we may find a sufficient one in the name of the Prince or ruler who governed at the time of the recorded event, which is always inserted in the inscription, grant, perwana, &c. that is to be expounded; provided such a Prince or chief be known to Indian history. The time of his birth, of his ascending the throne, and of his death, or the end of his reign, are the limits to be most depended upon. In default of these, the Epoch of some memorable event which may have occurred during his reign, or that of any of his known contemporaries, or even the time about which he flourished, may be considered as data, more or less to be depended upon, according to their degree of precision.

For although it be not impossible that the same individual should have possessed authority during sixty years of his life (in which case the question would be subject to two answers), yet as the contrary case is the most probable, there can be, in most cases, no very great fear of error when supposing any common reign to have lasted less than that number of years.

obtained; which if it be correct should give the Hindu Tropical mean Longitude deduced from the apparent one found on the Inscription, viz. $74^{\circ} 36' 42''$, (page 271).

Formula $T = S + 1 + 36C + A + m2 - dx$. (Prop. II.)

M. B.—As the value of the terms has been computed at page 281, the same quantities are to be used.

		$\beta =$		October 24		M. T. P.	
		day: $\div 36C + A + m2 =$		2 25		2 19	
For Son's Longitude.						26 42 18 40	
31st December 541	-	9	11 36 36.9				
October 1815	-	2	24 42 30.7				
8h.	-		19 42.8	- H	-	0	
0° 55'	-		7.3				
Longitude sought	-	7	6 36 42.3	- L	-	4 54 13	
				- dx	-	26 8 1 16	
				T =		26 5 58	

which is the same as above.

EXAMPLE I.

Let it be supposed that N, the Prince whose name appears on the face of the inscription, is known to history; and that he reigned in Bengal between the years of the Cali yug 3601 and 3651: the first step to be taken is, to expound the year of the Chacra which corresponds to the first of these two Epochs; and this will be effected by means of the rule given in the Postscript to the third Memoir, and Table XVIII.

Example according to the account of the *Sastras*.

By the said Table it appears, that the last expunged year of the Chacra before the year 3601 of the Cali yug, fell in the 3581st year of the same; answering to A. D. 480

but 3601 current, or 3600 complete, answers to A. D. 499
 difference 19

therefore we shall have 23 to add at the end of the rule. (*) To proceed,

19	20
60)3600(41	3600
160	+ 41
80	60)3641(60
—	41
74	+ 23
	9 Yura,

therefore Yura, the 9th of the Chacra, answers to the 3601st year of the Cali yug current; but from Yura 9th to Calayucta the 52d, there are 43 years; hence 3601 + 43 = 3644, the same year as that originally found on the inscription.

EXAMPLE II.

Let us suppose that a *permana* was granted by Serajee, the chief and founder of the Murrabta power, which was dated, among other designations no longer legible, *Vicari*, the 33d year of the Chacra.

Example according to the Tellings account.

As Serajee reigned in the Peninsula of India, the proposed Chacra year was no doubt computed according to the Tellings account; and to expound it we are to refer to the appropriate rule, disclosed in the third Memoir, and adverted to at page 143 of this work; the process of which is still more simple than the former.

Now as we know that Serajee died in the 4782d year of the Cali yug (4781 complete), answering to A. D. 1690, find the Chacra year corresponding thereto:

60)4781(79
681
41
+ 13
—
54 Raudra, the current year by the Tellings account.

(*) Vide Postscript to the 3d Memoir, page 213.

But *Vicari* is the 33d of the *Chakra*, and as the Epoch which we have expounded is that of *Sarajee's death*, it is manifest that the year sought is that which preceded *Raudra*, the 54th; hence $54 - 33 = 21$ years to be subtracted from 4752: we have therefore A. Cal. 4761, answering to A. D. 1659, for the Epoch which corresponds to the proposed *Vicari*, and which needs no further demonstration.

The Epoch being thus recovered, the *Ayanansa* may be computed, and the process for expounding any particular date of the same, (as shown in the first part of this article) will apply.

Lastly, it sometimes happens (though not in inscriptions, *perwanas*, nor grants; but in Astronomical documents) that the *Ayanansa* remains among the Elements which have been preserved, although the numeral of the year has been lost. This case admits of a ready and unerring solution, by means of Table XXXV, which in all cases will restore the Epoch, as must be well known to the reader.

SECOND CASE.

The most ancient Eclipse which has been transmitted to us by the Babylonians, occurred on the 19th March A. A. Christum 720; at 6^h 45^m p. m. Meridian of Paris. — Wanted the concurring Hindu Epoch of the same Eclipse under the Meridian of *Lanka*; together with the error of the Hindu Solar Tables at that time.

CAUTION.

1^o The year 720 before Christ is a Bissextile one; therefore for finding its Dominical Letters, we are to use the first part of Table VI.

2^o And because the proposed year ascends before the birth of Christ, for finding the commencement of the corresponding Solar Sydercal year, we are to use the third part of Table V.

3^o The notation of the year of the *Cali yug* will be $3102 - 720 = 2382$; and as it preceded the institution of the *Wra* *Vikramaditya*, and *Salivahana*, it cannot be expressed in the same.

4^o By Table V, part 3, as the 2302d and 2402d years of the *Cali yug* began on the 7th March, there can be no doubt but that the proposed year commenced very near to the same date in its own month of March.

OPERATION.

For the commencement of the 2382d year of the *Cali yug*, answering to A. A. C. 720,

	D.	S.	V.	P.
By Table VIII, part 2d, Initial Root, A. 700 B. C.	(0)	56	40	0
For 20 years, by Table I, subtract	(4)	10	25	0
Initial Root of A. <i>Cali yug</i> 2382	(3)	46	15	0

Santa dina, Wednesday.

To expound this *seria* into its European date, we find by Table V, part 3, that the Secular Christian year before Christ 700, began on a *Thursday*; and by Table VI, part 1st (the year being

The *Ayanansa* an
interesting clue for
recovering a lost
Epoch.

The date of an an-
cient Solar Eclipse
expounded into Hindu
Solar time.

A. A. C. 720. 6h 45^m
p. m. Meridian of
Paris.

A. *Cali yug* 2382
current.

For the time of be-
ginning of the Hindu
Solar year.

a Bisextile one) that 4 days are to be subtracted from the said Thursday in order to obtain the feria on which that year began, which falls therefore on a Sunday: hence the Dominical Letters sought are AG.

Now, as the date falls in March, with G as the Dominical Letter, refer to the Kalendar about the 7th of that month, and you will find that Wednesday (the Sonta dina) falls on the 7th of March.

7th March A. A. C. 720.

But the proposed date is the 19th, therefore adding 12 days to the 1st Vaisâcha, we have the 13th of that month current (the 12th complete) for the date of the Eclipse, and to have its precise time at Lanca according to Hindu reckoning, say,

	h.	'	"
Time from noon at Paris	6	48	0 p. m.
To count the time from Sun rising, add	6		
And to refer to the Meridian of Lanca	4	54	12

Time of Eclipse counted from Sun rise, European hours, &c. 17 42 12

The same converted into Hindu guddias, viguddias, &c. 44° 15' 12" after ☉ rising.

Answer.—The Hindu Solar date of the Eclipse which occurred on Monday the 19th March A. A. C. 720, at 6° 48' p. m. at Paris, would have been expected at Lanca on Monday, the 13th Vaisâcha of the 2382d year of the Cali yug, at 44° 15' 30" after Sun rise.

Hindu Solar time of Eclipse at Lanca.

Let us now consider what would be the error in the Sun's mean Longitude at that time, according to the Hindu Tables.

For the error of the Hindu Solar Tables.

I. We have seen that the month Vaisâcha and year 2382 of the Cali yug began on Wednesday, at 46° 15' 0", after Sun rise at Lanca, when the Sun's Sydereal Longitude was supposed to be = 0.

Now if we compute the Ayanansa for the beginning of the said year, it will be found = — 18° 17' 6".

Ayanansa = 18° 17' 6" means Tropical Longitude of 1st point in the Sydereal Zodiac 11a, 11° 42' 54" Hindu account.

	s.	'	"	"
The Sun's Tropical Longitude therefore was	12	0	0	0
	—	18	17	6
☉'s mean Tropical Longitude, 1st Vaisâcha 2382	11	11	42	54

which day as we have seen, fell on the 7th March A. A. C. 720.

II. The Hindu Solar date of the Eclipse being the 13th Vaisâcha (12th complete), the Sun's mean motion must be added to the above Longitude for that number of days.

Time wanting to complete the 12th Sydereal day.

	s.	'	"
But the Sydereal month began at	46	15	0
And the time of Eclipse was	44	15	20
Difference	1	59	30

} after ☉ rise.

which were wanting of the 12th Sydereal day complete, when the Eclipse was to occur; and during that time the Sun's mean motion was 1° 57' 8" which quantity is therefore to be subtracted. Hence,

Tropical Sun's Longitude at the time of Eclipse according to the Hindu Kalendar 11a, 23° 30' 37".

☉'s mean Longitude, 1st Vaisācha	-	-	11	11	42	54
His motion for 12 days	-	-		11	49	40
			11	23	31	34
Deduct the same for the incomplete day	-	-		—	1	57
<i>Ravi Sanyana</i> , or Sun's Tropical Longitude	-	-	11	23	30	37

according to the Kalender, but which is inconsistent with the existence of the Eclipse.

III. In order to find the error of the Hindu Tables, let the time for which it was predicted according to the Solar Kalendar, be equated by means of the formula given at page 253, Proposition II.

$$T = \beta + 1 + S_0 C + A + m a + dx,$$

OPERATION.

A. A. C.	730	nC = 24.	m 20.	SnC = 2° 56' 1" 36".	ma = 1' 28' 1".				
Epoch	1700	A = 7° 12'.							
(24 20									
Ayanamsa.									
Table XXXV,	18° 17' 4"								
do. XXXVI,	18 17 30								
Difference 20 answering to 10' 30" of time = dr.									
S	=	7° 20' 4"							
nC	=	× 24							
SnC	=	2° 56' 1" 36"							
a	=	4 24,04							
m	=	× 20							
ma	=	1 28 1							

Hence

	$\beta =$	March	19	44	15	30	
+ day + SnC + A + ma	-	-	3	57	36	49	
Equated Hindu time	-	-	23	41	52	19	
do. European time	-	-	23	16 ^s	44'	56"	from ☉ rising
— H	-	-	—	6			
			23	10	44	56	p.m.
— L	-	-	—	4	54	12	
			23	5	50	44	
+ dx	-	-	+	10	38		
, Meridian of Paris, T= March			23	6	1	23	p.m.

When the Sun's mean Longitude by Delalande's Tables, or Table LIII, will be found to be as follows:

☉'s mean Longitude, 1st January A. A. C. 720	2.	0	2	25	25,0
☉'s mean motion for 22 days, Table L.II; or 23d March	2	20	40	25,1	
Do. for 6 hours, 1' 23' do. part 2,			14	20,5	
☉'s mean Longitude sought		11	23	30	28,6

which differs only from that found by means of the *Ayanansa*, Article II, by 1',6.

IV. Now since the Hindu Kalen.

(1^{re}.)

dar supposed that the Sun's Tropical Longitude on Monday, March the 19th, at 11^h 42^m 12^s p. m. at Lanca (1^{re}), was

Lanca, March	10	44	15	30	from ☉ rising.
			15		

Hindu time 19 29 15 40 p. m.

(2^{re}.)

Paris, March 23 6 1 33 p. m.

Difference of Longitude 4 4 51 12

Lanca 23 10 55 35

10 11 42 12

Error in time 3' 23" 13' 23"

in degrees 3' 54' 38",4

Error of the Hindu Solar Tables in time 2d. 23h. 17' 23", in degrees 3' 54' 38",4.

that position on the 23d of the same month at 10^h 55' 35" (2^{re}), it follows that the Kalender was 3' 23" 13' 23" slow, (3' 58" 3' 27" Hindu time), during

which time the Sun would move through 3' 54' 38",4, which shows the quantity by which the Hindu Tropical Longitude of the Sun (or the Supplement of the Arc of *Ayanansa* to 12° at the beginning of the year) was *too great*; and consequently the *Ayanansa* too little.

Hence from the Longitude found at Article II, page 278	2.	11	23	30	38
Subtract error of Hindu Tables				3	54 38,4
☉'s correct mean Tropical Longitude		11	19	35	39,6
				6	
At the time of Eclipse		5	12	34	59,6

☉'s corrected mean Tropical Longitude 5h. 19' 35" 39",6.

To verify which

Compute the Sun's apparent Longitude answering to that above found.

☉'s mean Longitude	5	10	55	59,6
Equation of the center			1	42 57,6
Notation — 2',9				
☉'s Equation, 1st part				3,7
Do. do. 2d part — 2,1				
				— 5,0
☉'s Equation				1,2
☉'s do.				2,4
Subtract Notation and 2d part				
☉'s Equation	5	21	19	4,5
				— 5,0
☉'s apparent Longitude at time of Eclipse	5	21	18	59,5
The same computed by Dominique Cassini	5	21	27	0,0
Difference			8	0,5

Sun's apparent Longitude at the time of Eclipse.

Case where the Sun's apparent Longitude is found recorded on an Inscription.

For instance, let it be supposed that the Sun's apparent Longitude in the Syderal Elliptic $13^{\circ} 30' 41''$ was found recorded on an Inscription, with the year 2332 of the Cali yug, which reduced to his mean place would be $11^{\circ} 47' 41''$ (Article VI), if we compute the Ayanansa for the beginning of the said year, it will be — $13^{\circ} 17' 4''$ (Article III), and if we equate the time of beginning of that year, we shall find the error of the Hindu Tables to be $3^{\circ} 54' 33''.4$ (Article IV), therefore

From the Sun's mean Longitude	-	-	-	-	11 47 41
Subtract error	-	-	-	-	3 54 33
Corrected Madhyama Graha	-	-	-	-	7 53 3
Which subtract from Ayanansa	-	-	-	-	13 17 4
Rasi Sayana or distance to Equinox	-	-	-	-	10 24 1
					12° 0 0 0
Sun's Tropical mean Longitude corrected	-	-	-	-	11 10 35 59

And if we convert the same into time by reversing the process for using the Tables, it will be

Sun's mean Longitude 1st January A. A. C. 720	-	-	-	-	9 2 25 25
70 days	-	-	-	-	2 8 59 43,1
3 do.	-	-	-	-	7 53 0,6
6 hours	-	-	-	-	14 37,1
40 minutes	-	-	-	-	1 32,0
3 do.	-	-	-	-	19,4
Time expended 19th March at 6 ^h 48 ^m p. m.	-	-	-	-	11 10 36 0,1

which is the same as was originally proposed, within a trifling fraction of time, the latter Longitude being $1''$ greater.

POSTSCRIPT.

I intended to have confined this paper to the preceding pages: but having communicated to a learned friend the following computations of the error of the Hindu Solar Tables, as derived from the Solar Kalendar at the end of each Quadrant of the Ayanansa, when taken in its fictitious form (such as it now obtains among Native Astronomers), he was of opinion that these should not be withheld, because if any modern *Jyautik Sautra* should ever be qualified to read this work, he would find therein a clear proof of the absurdity of the system to which they are all so generally attached. (*)

I shall therefore give the calculations of the place of the first point in the Hindu Syderal Elliptic, in the Tropical one at the end of each Padak of the Ayanansa, using the formulae, an account of which was given in the body of this Appendix; and deduce the error of the place assigned to the Sun when in the said points by the Hindu Solar Syderal Kalendar, in the manner that was adopted in the preceding Examples.

(*) See the Diagram at the top of page 247.

CASE 1.

To find the Tropical Longitude of the first point in the Hindu Sydereal Ecciptic at the end of the first Padah of the Ayanansa, which falls at the expiration of the 1800th year of the Cali yug, answering to A. A. C. 1301.

The formula for this case will be

$$T = \beta + 1 + \frac{\text{day}}{360} (\text{SnC} + A + m a) + dx \text{ (Prop. II.)}$$

$$\begin{array}{l} 1301 \\ 1700 \end{array} \quad \text{where } nC = 30. \quad S = 7^{\circ} 20' 4''. \quad A = 7^{\circ} 12'. \quad m = 1. \\ (30)01 \quad ma = 4^{\circ} 24',04.$$

$$\text{SnC} + A + ma = 3^{\circ} 40' 13' 56''.$$

Ayanansa.

Tropical Longitude of γ .

Table XXXV,	27	0	0	27	0
do. XXXVI,	27	0	37,5	27	
			37,5	11	3

answering to $15^{\circ} 12'$ of time $= dx$.

And if we expound the time of commencement of the 1801st year of the Cali yug by the rules which were given in the Key to the Madhyama Saura mana, it will be found to fall on March the 3d, at $23^{\circ} 33' 45''$ after Sunrise, under the Meridian of Lanka $= \beta$.

OPERATION.

$\beta =$ March	3	23	38	45	from \odot rise.
$1^{\circ} + \text{SnC} + A + ma =$	-	4	40	13	36
Sum in Hindu goddess, &c.	8	8	52	21	
do. in European hours, &c.	8	8	52	56,4	
- 11	-	6			
	7	21	32	56,4	p. m.
- L	-	4	54	12	
	7	16	38	44,4	
+ dx			15	12	
Time equated, Meridian of Paris, T = March	7	16	53	56,4	p. m.

For the Sun's mean Longitude by the European Tables, at the equated instant of time.

By Table I.II, \odot 's mean Longitude 31st December A. A. C. 1302	8	27	15	12,2
\odot 's mean motion for 66 days, or March 7th	-	2	5	3
do. for 16 hours	-	-	39	25,5
50 minutes	-	-	2	3,2
3 do.	-	-	-	7,4
50 seconds	-	-	-	2,1
6 do.	-	-	-	2
\odot 's mean Longitude at Equated time	11	2	59	59,9
	12			
European Ayanansa	0	27	0	0,1
differing only $0^{\circ},1$ from the Hindu Ayanansa.				

For the error of the Hindu Solar Tables.

By the Hindu Kalender the Sun is supposed to have entered the Sign Υ on the 3d March A. A. C. 1501, at $5^h 27' 30''$ p. m. (1^o), at Lanca; and the Sun's Longitude on the 7th of the same month was $11^{\circ} 2' 59' 59''.0$ at $21^h 48' 3''$ p. m. also at Lanca. The error of the Hindu Tables was therefore $4^{\circ} 30' 49''.6$ in *plus*, which is to be subtracted from the Sun's mean Hindu Longitude

in order to have the true one at the time referred to.

CASE 2.

The same for the commencement of the 3601st year of the Cali yug, answering to A. D. 499, when the Ayanansa completed its second Padah. The formula being the same as in the preceding case.

End of the second Quadrant.

1700
409

$$nC = 12. \quad ma = 4^{\circ} 24'.04. \quad SnC + A + ma = 1^{\circ} 26' 12''.24.$$

(12)01

Ayanansa and Longitude

by both Tables = 0; therefore $dx = 0$.

And expounding the time of commencement of the Hindu Solar year as usual, we have

	G. Y. P.
$\beta =$ March 19	6 8 45
$1^{\text{st}} \text{ day} + SnC + A + ma =$	2 28 12 24
Sun, Hindu time	21 34 21 2
	21 13 44 27,6
— H	— 6
	21 7 44 28
— L	— 4 54 12
Equated time at Paris, T = March	21 2 50 16

For the Sun's mean Longitude by the European Tables,

Table I.H. \odot 's mean Longitude 31st December A. D. 498	9 11 1 54,9
\odot 's motion for 80 days or 21st March	2 18 51 6,4
do. for 2 hours	4 55,7
50 minutes	2 3,2
10 seconds	4
5 do.	2
\odot 's mean Longitude at Equated time =	0 0 0 0,2

differing only $0''.8$ from the Hindu Ayanansa.

For the error of the Hindu Solar Tables.

By the Hindu Kalendar the Sun is supposed to have entered the Sign γ on the 18th March A. D. 492, at $20^{\circ} 27' 30''$ p. m. at Lanka (1°), and the Sun's Tropical Longitude was $0^{\circ} 0' 0''$ on the 21st March at $7^{\circ} 44' 27''$ p. m. also at Lanka, by the European Tables. The error of the Hindu Tables was therefore $2^{\circ} 26' 4'',8$ in *plus*, as in the foregoing case, and is therefore subtractive of his Hindu Longitude at the time referred to.

1^o

a. r. p.
March 19 5 8 45 from \odot rising.
— 15

18 51 8 45

March 18 20 27 30 p. m.

2^o

n. s. s.
March 21 2 50 15
+ 4 54 12

21 7 44 27 p. m.

18 20 27 30

Error in Hindu time $2^{\circ} 11' 16'' 57''$

do. in degrees $2^{\circ} 26' 4'',8$

Case 3.

End of the third
Quadrant.

The same for the commencement of the Hindu Solar year 5401 of the Call yug, answering to A. D. 2299, when the Ayanansa will complete its third Quadrant.

In this case the formula becomes

$$T = p + 1 - (SoC + B + ma) - dx.$$

$$\frac{2299}{1800} \quad nC = 4. \quad m = 99. \quad ma = 99 \times 4^{\circ} 24p,04 = 72^{\circ} 13' 40p.$$

$$\frac{(4)99}{(4)99} \quad SoC + B + ma = 432^{\circ} 48' 48p. \quad B = 72^{\circ} 12' 52p.$$

Ayanansa and Longitude.

Table XXXV, 27 0 0

do. XXXVI, 27 0 37,5

Difference 37,5

answering to $16' 15'' = dx$.

And expounding the commencement of the Solar year as usual, we shall find

a. r. p.
+ 1 day $\beta =$ April 3 43 38 45
— 1
4 43 38 45
— SoC + B + ma = — 43 48 48
Remainder, Hindu Time . 5 59 49 57
do. to European hours . 3 23 25 58,6
— H — 6
3 17 55 59
— L — 4 54 12
3 13 1 47
— dx — 15 15

Equated time at Paris, T = April 2 12 46 32

For the Sun's Longitude in the Tropical Ecciptic by the European Tables.

By Table LII, ☉'s mean Longitude 31st December A. D. 2298	a.	0	24	49	36,2
☉'s mean motion for 93 days, or 3d April		2	31	39	54,7
do. for 12 hours				20	54,2
45 minutes				1	53,4
32 seconds					1,3

☉'s mean Longitude at Requested time

a.	0	25	59	59,8
----	---	----	----	------

differing only 0',2 from the Hindu Ayanansa.

For the error of the Hindu Tables.

By the Hindu Kalendar the Sun, it is

19

supposed will enter Mesha γ on the
3d April, A. D. 2299, at 11^h 27' 30"

p. m. at Lanca; and the Sun's Longi-
tude on the same day at 17^h 40' 44"

p. m. was 26^h 59' 59",8 also at Lanca.

The error of the Hindu Tables will

therefore be 15' 19",7 in *plus*, and as

in the preceding case, is to be subtracted

from the Sun's mean Hindu Longitude at the time referred to.

2^a

Paris, April

Lanca, -

Error in time

do. in degrees

g. v. r.
April 3 33 38 45 from ☉'s pos.
— 15

3 28 38 45

3 11^h 27' 30" p. m.

n. v. r.

3 12 46 32

+ 4 54 12

3 17 40 44

3 11 27 30

0 0 13 14

15' 19",7

CASE 4.

The same for the commencement of the year 1 of the Cali yug, answering to A. A. C. 2101, and for that of A. Cal. 7201, answering to A. D. 4000, at both of which Epochs the Ayanansa is supposed by the Hindu Astronomers, to be in the beginning of its first Quadrant.

Beginning of the 1st
and end of the 4th
Quadrant.

These two cases are to be resolved by means of the formula exhibited at Propositions II and III respectively (page 253), the first being applicable to all years ascending from A. A. C. 1301 in the first Quadrant, and the second to those descending from A. D. 2299 to 4000 in the fourth Quadrant of the Ayanansa. (*) As both these Epochs are very remote, the reader may not be displeased to find here a last Example of the manner of expounding the beginnings of A. Cal. 1 and 7201.

FIRST EPOCH:

I.

For the value of ρ in A. C. 1.

By Table VIII, A. A. C. 3000	n.	0.	v.	r.
Table 1, for 100 years, subtract	(3)	58	45	0
	(6)	52	5	0
Do. for 1 year, subtract	(4)	6	40	0
	(1)	15	31	15
Initial Root, A. C. 1, sought	(2)	51	8	45

1st Epoch, A. Cal. 1
A. A. C. 2101.

Soota dina, Tuesday:

(*) Vide Diagram.

half of which is 27° , shows that whereas the Tabular Ayanansa goes on increasing (and its Supplement decreasing) from A. A. C. 1201 to 3101, the Epicircular one has a contrary progress; so that whatever view ancient Astronomers may have taken of that Element at the time referred to, it is certain that their modern successors would equate it into $+ 27^\circ - 27^\circ = 0$.

In order to deduce the error in the Sun's mean position which would result from such a theory, we are not therefore to confine ourselves to a comparison of "what the Sun's Longitude is supposed to be and really is at the given instant at Lanka," as we have done hitherto; but we are also to account for 54° of Ayanansa, rejected by the absurd system of Libration, which answer to $54^\circ 13' 52'' 22''$ of time.

IV.

For the error of the Tables.

Now by the preceding operation it appears that by the Hindu Kalendar, the Sun entered Mesha γ on the 15th February at $14^\circ 27' 30''$ p. m. at Lanka (1st), in A. A. C. 3101; and that the Sun's Tropical Longitude according to the European Tables was $10^\circ 5'$ on the 22d February at $11^\circ 51' 45''$ p. m. also at Lanka (2nd), the first part of the error of the Hindu Tables is therefore $5^\circ 47' 34''.6$, and the second $1^\circ 24''$, amounting in all to $2^\circ 0' 47' 34''.6$ in *plus*, as before,

(1st)

	H.	'	''
February 15	51	8	45 from \odot rise.
	— 15		

Hindu time	15	36	8	45
------------	----	----	---	----

February 15	14	27	30	p. m.
-------------	----	----	----	-------

(2nd)

	H.	'	''
February 22	6	67	33 p. m.
	+ 4	54	12

February 22	11	51	45	
	15	14	27	30

Error in time	5	21	24	15	p. m.
---------------	---	----	----	----	-------

do. in degrees	5	47	34''.6
	+ 1	24	0 0

Total error =	2	0	47	34''.6
---------------	---	---	----	--------

by which the Hindu Astronomers of ancient times, (or rather some more recent speculator deceived at the time of observation by the effects of the Solar Equation and the nutation of the Earth's Axis, which he could not otherwise explain) would have mistaken the Sun's position relatively to the Equinoxes, at the commencement of the Cali yug; a supposition wholly untenable.

SECOND EPOCH.

I.

The same resolution for the beginning of the 7201st year of the Cali yug, answering to A. D. 4099. 2d. Epoch, A. C. 7201, A. D. 4099.

The formula in this case is $T = \beta + 1 - (SnC + B + ma) - dx$.

Proceeding as usual for the value of β by means of Tables I and VII, we shall find the initial root for A. C. 7201, answering to A. D. 4099, to be (0) 21 8 45.

and the Soota dina Sunday;

to expound which the Dominical Letter may be found as follows:

II.

The series in Table V, part I, extends only to A. D. 2000; but that which we want, as it refers to the Julian Kalendar, may easily be deduced from that Table, by extending it to the given year; a process which hardly requires two minutes of time. In this manner the Dominical Letters for A. D. 4100 will be found to be CH, and that for the preceding year, now wanted, D.

For expounding the *Scota dina, Sunday*, into its European date, we find (arguing as we did in the preceding article) that in 2000 years descending, the beginning of the Hindu Solar year retards 17 days in the European corresponding Julian year. But in A. D. 2000 it began on the 21st March; adding therefore 17 days thereto for the year concurring with A. D. 4000, and then adding again a day (nearly) for each century, we are sure to find the beginning of the 7201st of the *Calî yug* (A. D. 4099) about the 18th April.

Referring therefore to the Kalendar with the Dominical Letter D, we find that *Sunday*, the *Scota dina*, will fall on the 19th April A. D. 4099.

The value of β will accordingly be, April 19th, $21^{\circ} 8' 45''$.

III.

To expand the formula we have, therefore,

$$\begin{array}{r} 4099 \\ 1800 \end{array} \quad nC = 22. \quad m = 99. \quad m\alpha = 99 \times 4^{\circ} 24,04 = 7^{\circ} 15' 40''.$$

$$\frac{(22/99)}{\text{Ayanausa and Longitude,}} \quad 5nC + B + m\alpha = 24^{\circ} 55' 50'' \text{ Og.} \quad B = 7^{\circ} 12' 52''.$$

Ayanausa and Longitude,

Table XXXV,	1	24	0	0
do. XXXVI,	1	24	1	14

Difference 1 14

answering as before to $30' 20''$ of time $= dx$.

	$\beta =$ April	19	21	8	45
+ 1 day	-	+	1		
			20	21	8 45
- $5nC + B + m\alpha$	-	-	2	55	50 0
Remainder, Hindu time			17	25	18 45
Do. European time			17	10	7 30
- H.			-	6	
			17	4	7 30
- L.			-	4	54 12
			16	23	13 18
- dx			-	30	20

Equated time, Meridian of Paris, T = April 16 23 42 58

For the Sun's mean Longitude by the European Tables at the Equated time.

IV.

By Table LII, Sun's mean Longitude 31st December 4098,	- 10	8	35	17,0
Sun's mean motion for 106 days, or 16th April	-	3	14	28 48,0
22 hours	-			54 12,6
42 minutes	-			1 43,5
28 seconds	-			2,4

Sun's mean Longitude at Equated time 1 23 59 50,4

differing only by $0^{\circ},6$ from the Hindu Ayanausa.

For the error of the Hindu Tables.

By the Hindu Calendar the Sun is supposed to enter Mesha γ on the 15th April at $2^h 27^m 30^s$ p. m. A. D. 4000, at Lanka, and the Sun's Tropical Longitude was found $1^h 24^m$ according to the European Tables on the 17th April at $3^h 37^m 10^s$ p. m. also at Lanka.	1 st	April	$\begin{array}{r} \text{C. T. P.} \\ 19 \ 21 \ 8 \ 45 \text{ from } \odot \text{ rising} \\ \hline 15 \\ \hline 19 \ 6 \ 8 \ 43 \end{array}$
		April	$\begin{array}{r} 19 \ 2 \ 27 \ 30^s \text{ p. m.} \end{array}$
	2 nd	April	$\begin{array}{r} \text{H. } ^\circ \ ' \ '' \\ 16 \ 22 \ 42 \ 58 \text{ p. m.} \\ + \ 4 \ 54 \ 12 \end{array}$
		April	$\begin{array}{r} 17 \ 3 \ 37 \ 10 \\ \hline 19 \ 2 \ 27 \ 30 \end{array}$
	Error in time	-	$\begin{array}{r} 1 \ 22 \ 50 \ 20 \\ \hline \end{array}$
	in degrees		$1^h \ 55' \ 24''.9$
	Error of Ayanansa		$1^h \ 24' \ 0''$
	Total error	-	$\begin{array}{r} 1 \ 25 \ 55 \ 24.9 \end{array}$

Now as the Ayanansa goes on increasing in the Tables with a contrary Sign from that which it had at the preceding Epoch, whereas according to the Libratory doctrine it decreases from A. D. 2299 descending until in A. D. 4099, when it becomes equal to zero, making the Ayanansa 54^h equal to $+ 27^h - 27^h = 0$, it follows that the error of the Tables deduced from this operation amounts to $1^h \ 55' \ 24''.9$ in its first part in *minus*, and consequently is to be added to the mean Hindu Longitude; and in the second to $1^h \ 24'$ also in *minus*, therefore the whole error is $1^h \ 55' \ 55' \ 24''.9$, which was to be determined.

END OF APPENDIX II.

APPENDIX III.

TRACT ON CHRONOLOGY,

With directions for referring dates recorded in any of the three principal HINDU STYLES, to corresponding ones of any æras registered in the annexed CHRONOLOGICAL

TABLE : with an account of the ancient and modern Jewish years.



APPENDIX III.

A Sketch of some of the principal Æras and Periods of ancient times, referred to in Chronology; with directions for finding the corresponding years in each of them, to any year proposed according to the Hindu styles of the Cali yug, Vicramaditya, and Salivahana.

In publishing this short tract, which merely consists of extracts from books on Chronology, I am far from imagining that I present any thing new to the attention of the learned reader: but the experience of thirty years in India has taught me, that let works on such topics be ever so common in Europe, they are seldom, and in many cases, no where to be found when wanted in this part of the world.

If any thing could excuse an Indian author for having failed in point of accurate reference, or presented under the garb of novelty, a piece of information which may perhaps be found in every library in England, it would certainly be the penury of books on the sciences here complained of. Indeed it has come to my personal knowledge in another path of research (independently of the origin of the third Memoir of this collection), that the greatest Geometer that came to India since the days of Mr. Robins, (*) was frequently reduced, in order not to interrupt a work which will transmit his name to posterity, to analyze Problems, and construct Tables, which had been resolved and constructed more than a century before his time.

To return to our subject, I thought that my task would remain incomplete if, after having explored the principal Hindu doctrines which relate to time, I were not to furnish some means for referring them to accounts probably equally ancient, and certainly much better known to the generality of readers. I trust, therefore, that the present endeavour to collect in a small compass a few of the leading features of ancient Chronology, will not be deemed (at least by my Indian readers) a useless increase of this volume.

EXTRACTS, &c.

The words Æra and Epoch generally mean the same thing in Chronology. Sometimes however, Epoch is specially used to designate the particular time of an event, without reference to any Æra: we find it also employed in the sense of the beginning of an Æra.

(*) The late Lieut. Colonel William Lambton, Superintendent of the Grand Trigonometrical Survey of India, to whom the author was, during several years, an assistant. It is also related of the late Mr. Andrew Scott, that whilst in the Northern Circars, and wanting a Table of Logarithms, he found no shorter way to procure one, than to construct it himself.

In order to reduce the various accounts of time which have been used by mankind to a common scale, a period of years was invented which, commencing before all known Epochs, involves them all. Such is the *Julian period*, invented by Joseph Julius Scaliger about the middle of the XVIIth century.

The Julian period.

Of the Julian period.—This period is a series of 7980 years, arising from the multiplication of the Cycles of the Sun, Moon and Indiction; or of the numbers 28, 19, 15; its Epoch commencing on the 1st day of January of the 706th year before the Creation. The Julian period therefore, is not yet completed.

As every year of that period has its particular Solar, Lunar, and Indiction Cycles; and as no two years in it can have all these three Cycles the same, any year that can be proposed is accurately distinguished from all the rest.

We shall postpone the application of this and following observations to our purposes, until after an account of the most useful Æras has been laid before the reader.

Solar Cycle.

2. The *Solar Cycle*.—A period of 28 years, beginning with 1 and ending with 28.

Metonic or Lunar Cycle.

3. The *Metonic or Lunar Cycle*.—A period of 19 years. It only holds true for $310\frac{2}{3}$ years, because on every 19th year the Moon returns near an hour and a half sooner, which error in $310\frac{2}{3}$ years, amounts to an entire day.

Indiction.

4. *Cycle of Indiction*.—A period of 15 years revolving like others, and commencing (by anticipation) 3 years before A. D. 0 complete; or 1 current of the Dionysian account: So that if 3 be added to any proposed year of Christ, and the sum be divided by 15, the remainder (neglecting the quotient) marks the year of Indiction. The first Indiction was settled and agreed upon in A. D. 313.

Mundane Æra.

5. The *Mundane Æra*, or Epoch of the Creation of the World.—The best authors of Port Royal, in whose number was the celebrated Pascal, and Le Maître de Saci, place that event 4004 years before the vulgar or Dionysian Æra. The Jews however, made it 243 years later, or A. A. C. 3761, which is still the Epoch of their Mundane Æra. (*)

Calijug.

6. The *Calijug* of the Indians.—A period of 432000 years, of which 3101 had expired on the 14th March A. D. 1 current. It is taken to have begun on Friday, the 18th February.

Æra of Nabonassar.

7. *Æra of Nabonassar*, first King of the Chaldeans or Babylonians.—Its Epoch is taken to fall on Wednesday, 26th February A. A. C. 747. Its year was of 365 days, without any intercalation on the 4th.

Olympiads.

8. *Olympiads*.—A period of 4 years, the first of which began (it is supposed) with the nearest New Moon to the Summer Solstice A. A. C. 776, being the 3958th year of the Julian period, and 24 years before the foundation of Rome. The best Chronologists have computed that, the 1st year of the 1st Olympiad coincided with the 1st year of Incarnation, consequently

(*) Vide Note at the end of this Appendix.

the 5th year of Christ answers to the 1st of the 196th Olympiad. The Olympiadic years began with the Summer Solstice, or rather on the 1st July, so that the six first months of any year of Incarnation answer to one year of the Olympiad, and the six last to another.—The last of these periods was the 40th; and corresponded to A. D. 440.

9. *Indian Vicramaditya*.—An Indian Prince who is supposed to have ascended the throne 57 years before Christ. In the northern parts of India, instead of numbering their Luni-solar years from the beginning of the Cali-yug, the Natives count them from the accession of Vicramaditya. This denomination however, makes no difference in the construction of the Luni-solar year.

Indian Era of Vicramaditya.

10. *Cæsarion of Antioch*.—An Epoch established by the inhabitants of that town, in commemoration of Cæsar's victory at Pharsalia, A. A. C. 47. The Syrians made it begin in the month of August, or on the 9th Scetilis of that year (as it was then called), in which the Greeks differed: the latter fixing it on their month *Gorpheus* of the preceding year 705 of Rome, or A. A. C. 48, being the Epoch most generally used.

Cæsarion of Antioch.

11. *Iberian or Spanish*.—This Era, which is grounded on the Julian Calendar, owes its rise to the conquest of Spain, which was achieved by Augustus in the year 715 of Rome, but its Scitilous Epoch dates from the 39th year before Christ, beginning with the 1st January of the ensuing year. This Era was long used in Spain, Africa, and the Southern Provinces of France, and was finally abolished in A. D. 1415.

Iberian or Spanish.

12. *Indian period Grakaparrerithi*, of 90 Solar years, used in the Southern Provinces of the Peninsula of India.—It is stated to be constructed of the sum of the products in days of 15 revolutions of Mars, 22 of Mercury, 11 of Jupiter, 5 of Venus, 29 of Saturn, and 1 of the Sun. Its Epoch is A. A. C. 24. Its years vary by a few hours.

Indian Grakaparrerithi.

13. *Of Constantinople*.—In that period the first year of Incarnation falls in 5500, and answers to the last year of the 195th Olympiad.—This account subsisted as long as the Greek Empire, and the Russians preserved it until the reign of Peter the great. The years of this Era are either Civil or Ecclesiastical, the first begins with the 1st September; the second sometimes on the 21st March, and at others on the first April.

Era of Constantinople.

14. *Of Alexandria*.—The first year of the Incarnation answers to the 3503d of that period. It was followed by several of the General Councils, and used in some of the most ancient computations. Like the preceding account, it is supposed to refer to the Creation of the World, but assigning a different Epoch to that event from other accounts.

Of Alexandria.

The *Mundane Era*, called that of the Greeks, is the same as that of Alexandria.

15. *Ecclesiastical of Antioch*.—The 1st year of the Incarnation was taken to correspond to the 5493d of that period; retarding the Epoch of the Creation by 10 years more than the Alexandrian account.

Ecclesiastical of Antioch.

Indian
Chakra.

16. The Indian *Vrihaspati Chakra*, or Cycle of 60 of Jupiter's years.—This Cycle is constructed on the hypothesis that a revolution of the Planet Jupiter, is equal to 12 of its own years, and consequently 6 revolutions to 60 *Vrihaspati* years.—These kind of years (if they ever were) are no longer used as an immediate measure of time; but as each of these bears a specific name, they serve for giving a particular designation to every Solar and Luni-solar year during its scope of 60 years, after which the series begins anew in the same order. In the Northern Provinces of India, when Astronomers compute the succession of these years, they refer still to the revolutions of the Planet; in consequence of which, one year is expunged every 80th Solar year.—But the Telinga Astronomers make no difference between the *Vrihaspati*, and Solar years, and consequently expunge nothing; so that their years correspond to a different point of the Cycle, or Chakra, and bear a different name.

The year current of the Chakra on the first year of the Christian *Æra*, was *Sadhara*, the 44th of the 58d Cycle (vide Postscript to the third Memoir.)

Of the Seleucidæ.

17. Of the *Seleucidæ*, of which there are two.—These periods are also called of the *Syro-Macedonians*, because they originated with the successors of Alexander the great.

The first.

The first *Æra* of the *Seleucidæ* takes its rise from the death of Alexander, i. e. A. A. C. 323. It was little used.

The second.

The second has its Epoch 12 years later, and therefore dates 311 before Christ. It survives to the year of Rome 442, and its years are *Julian*. This *Æra* has been much in use among the nations of the Levant, and is still followed by the Catholics of Syria. The Jews, after their subjection to the Kings of Syria, adapted it, giving it the name of *Tach-Dikouran* (the *Æra* of Bargains), because they used it in their commercial transactions.

The *Æra* of the *Seleucidæ*, is still in use among the Arabs. *Alfragan* made its year begin on the 1st September, but *Albitagui* on the 1st October.

Indian *Æra* of Sa-
vabhana.

18. Indian *Æra* of *Savabhana*.—The name of a Prince supposed to be born 72 years after Christ, and a descendant of *Vijayaditya*; of which some account is given at article 9.—This *Æra* serves to number the Solar years by a shorter account than from the *Calijug*; in the same manner as the *Æra* *Vijayaditya* is used for the Luni-solar years. The Solar years expressed from the birth of *Savabhana* are called *Saon*.

Its years called
Saon.

Æra of the Martyrs.

19. Of *Dioclesian* or the *Martyrs*.—This *Æra* owes its rise to the elevation of that Emperor to the throne. It is called of the *Martyrs*, on account of his persecution of the Christians. Its Epoch is A. D. 284, and its year begins on the 29th of August. The *Æra* of *Dioclesian* is still used by the Copts and Ethiopians.

Of the Hegira.

20. Of the *Hegira*.—An *Æra* followed by the Mahomedans all over the world; its years are *Lunar*, and of 354 and 355 days, as they are common or intercalaries. It has a Cycle of 30 years,

which ^{is} always of 365 days. Its Epoch is the 16th July 622, but according to most Arabian Astronomers the 15th of the same month.

21. The two Persian Eras.—1^o That of *Yezdegird III.*, King of Persia. 2^o That of *Maleck Shaw Dgelut-ul-deen*, Sultan of *Korassan*. The two Eras.

The Yezdegirdic.—The Epoch of this Era refers to the accession of that Prince, which The Yezdegirdic. took place on the 16th June A. D. 632; ten years after that of the Hejira. The years of this Era were vague and of 365 days, and the months of 30; but at the end of the month *Aden* it was customary to add 5 days; which intercalations the Astronomers only introduced at the end of the year. This style was followed in Persia until it was reformed, and superseded by,

The Dgelalean.—*Maleck Shaw Dgelut-ul-deen* reformed the *Yezdegirdic* Calendar in the year of Christ 1079. Having assembled a council of eight Astronomers for that purpose, they determined that the Vernal Equinox should be fixed on the 14th of March. They maintained the 5 Intercalary days or *Epagomenes* which the *Yezdegirdic* had borrowed from the Egyptian year, but during 6 or 7 periods of four years (*) they found it necessary to introduce a sixth *Epagomen*, as an incidental Equation, after which periods the intercalation of the 5th day would only take place every five years. The Dgelalean.

The Persian Tropical year consists of $365^{\circ} 4' 45' 15'' 0' 49''$, which period brings back the Equinoxes and the Solstices on the same days of the year, better than the Gregorian revolutions.

The *Dgelalean*, or *Mulalean* style (as it is sometimes called) is still in use in Persia. Although it be not noticed in the Table of Epochs inserted in this article, it may be useful to And here the names of the Persian months and days.

The Months.

1	{ Asradia, or Aphradia.moh,	5	{ Merded, or Mordad.meh,	9	Adar.meh,
2	{ Ardibehst, or Ardisbehst.moh,	6	Shchirwir.meh,	10	Di.meh,
3	Cardi.moh,	7	Mehur.meh,	11	Behm.meh,
4	Thir.meh,	8	Abeu.meh,	12	{ Afiwer, or Asirer.meh.

The 5 *Epagomenes* in the common, and the 6, in the redundant years, are called *Mastaraca*.

The Persians do not divide the month into weeks, like other nations, but they give to each day a specific name.

Names of the days.

1	Hormozd,	13	Tir,	25	Erd,
2	Behman,	14	Dghionsh,	26	Ashtad,
3	Ardabehst,	15	Ikhameher,	27	Osman,
4	Sharivar,	16	Meher,	28	Hawad,
5	Espendarmod,	17	Souroush,	29	Marasfend,
6	Khordad,	18	Rosh, or Roush,	30	Anirao.
7	Mordad,	19	Farardin,	<i>Mastaraca, or Epagomenes.</i>	
8	Dibadur,	20	Behram,	1	Almond,
9	Azur,	21	Ram,	2	Ashmaul,
10	Aban,	22	Bod,	3	Espendarmar,
11	Khord,	23	Dibadin,	4	Vahest,
12	Mab,	24	Din,	5	Hoshooneth.

(*) I can find in no book which of the two numbers was used.

Era of Parasurama. 22. *Era of Parasurama.*—An account of time used in that part of the Peninsula of India called *Malayala* by the natives; extending from *Mangalore*, through the Provinces of *Malabar*, *Coliote*, and *Travancore*, to *Cape Comorin*. It derives its name from a Prince who is supposed to have lived in the year 1176 before Christ, and who was a great encourager of Astronomy.

Dr. Buchanan states that the inhabitants of *Malayala* reckon time in Cycles of 1000 years from that Epoch; and that their year begins when the Sun enters the Sign *Canya* ♍ (*Virgo*): answering to the Hindu Solar month *Aswina* (*Tamil Paratasi*); and furthermore, that in September A. D. 1800 there were two Cycles and 970 years expired of that *Era*, the year commencing, being the 977th of the 3d Cycle.

As the Christian year 1800 answers to the 4063d of the *Calli yug*, and 1729 from the birth of *Salivahana* current; and as by these accounts, which represent the same year, the new year began on Thursday the 10th of April (see General Table I), it follows that the Sun will have entered *Canya* ♍ on Sunday the 14th of September ensuing. (Page 14, and Table III).

The concurrence is therefore as follows :

The commencement of the 977th year of the 3d Cycle of *Parasurama*, answers to the 1st *Aswina* (*Tamil Paratasi*) of the 4902d year of the *Calli yug* or 1723 *Saca*; and to the 14th September A. D. 1800.

From what has been stated it also results, that the number of years of the *Era of Parasurama* expired on the birth of Christ, are 1176, and that the 1177th began on the 1st of *Aswina* A. C. 3104, answering to the 17th of August A. D. 1, Julian style. (Tables V, 2d part, and VII).

And lastly, that the Epoch fell on the 7th August of the year 2637 of the Julian period, answering to the 1226th of the *Calli yug*.

Era of the ancient Jews.

23. *The ancient Jewish Era.*—Although the two *Eras* of the Jews, and the Lunar-solar year of the Ancients (as given by *Montucla* in his History of the Mathematics, without mentioning the name of the nation which used it) are not included in the Table here annexed, yet as there are many Jewish tribes under the Bombay Presidency, who may be supposed to reckon time according to either, and as both are very little known to Europeans in this part of India, I conceive that some mention of these styles is not foreign to the object of this paper.

Of the ancient *Era* I have not been able to collect any very distinct account; I understand that it is never referred to by Chronologists, but for times before Christ; what follows will therefore be sufficient for the present purpose.

That *Era* was composed of Lunar years, reckoned from the Creation, which the ancient, as well as modern, Jews place 3761 years before the birth of Christ. The year was of 12

Lunar months, but originally fitted to the Solar one, by adding 11 and sometimes 12 days at the end of the year; but when it assumed a more regular shape, it became embolismic, and subject to a 13th Lunar month. The series of these intercalations, however, I find expressed nowhere; but is probably the same as that of the modern Jews. In intercalary years, the month *Adar* was repeated, being of 29 days in common, called defective; and of 30 in embolismic, called redundant.

Again in the defective, *Cisleu* was only of 29 days, and in the redundant *Marshermum*, was of 30.

The names of the ancient months were the same as the modern ones, the only difference being that the old Jewish style begins the year with *Nisan*, and ends it with *Adar*; whereas the modern begins it with *Thieri*, and ends it with *Elul*. The ancient Jews made much use of the *Æra* of Nabonassar, of which some account has been already given; and their Lunar-solar year is still the Ecclesiastical one in present times; at least as far as regards the season when it begins and ends.

A distinction to be made between the Indian, and Jewish years of both styles is, that the embolismic months of the former may fall on any of the five long Solar months of the year, whereas those of the latter invariably fall on the month of *Adar*.

21. *Of the Mundane Æra of the Jews, also called the modern.*—This *Æra* is likewise composed of Lunar years of 12 and 13 months, the intercalations falling on the 3d, 6th, 8th, 11th, 14th, 17th and 19th of the Metonic Cycle. The modern Jews pretend that its institution dates from high antiquity, but most Chronologists affirm that it was unknown before the XIVth century, although some say that it is to be traced up to the XIth. In this account of time, the whole expired duration of the *Æra* is divided into Cycles of 19 years, and of these 128 had elapsed on the birth of Christ; the last of which ended in the autumn of the first Christian year.

Mundane Æra of the Jews, also called the modern.

The Lunar months of the Mundane *Æra*, which bear the same names as those of the ancient one, are alternately of 30 and 29 days: they are reckoned like those of the Hebræ, to begin on the first appearance of the Moon after the conjunction.

We have already observed that the modern year begins with the month *Thieri*, instead of that of *Nisan*, i. e. 6 months later. In embolismic years the month *Adar* is likewise repeated, but the name of the second *Adar* is changed into that of *Fe Adar*, and in the order of the Kalendar, is the 7th of the year; so that *Nisan* becomes the 8th, *Jiar*, or *Istar*, the 9th, and so forth to *Elul*, which (in the supposed case) is the 13th.

The *Civil* year of the Jews begins with the new Moon of September, and the *Ecclesiastical* with that of March; the former following the new, the latter the old Kalendar.

Civil year of the Jews.

Independently of the modern year being distinguished between common and embolismic, each of these distinctions is also subdivided into three sorts, viz. the deficient, the mean, and the redundant, or superabundant,

Both common and embolismic years, distinguished into deficient, mean, and redundant.

Discarded or unlawful days of the Jews.

In order to understand how the Jews determine practically these different species of years, it is necessary to know that they have certain *discarded* days, on which it is not permitted to celebrate the great festivals of the year, such as *Easter-day*, the *Tabernacles*, and *Pentecost*, or *Whit-sunday*; for when these happen to fall in the common course of time, on any of the unlawful days, they are respectively transferred to the next lawful one. These contingencies are ruled by the following two precepts, expressed in a few Latin words.

1^o *Nunquam Nisan in Badu.*

2^o *Nunquam Thiersi in Adu.*

Badu expressing the numbers, 2, 4 and 6, and *Adu* 1, 4 and 6, the prohibited feria or weekly days.

The *Kebis* or lawful days.

Should therefore the new Moon of *Nisan* fall on the 2d, 4th or 6th feria, its observance is forbidden on those days, lest *Easter-day*, which is always kept on the 15th of that Moon, should fall on an unlawful day; those on which the Ecclesiastical year is permitted to begin, being called *Kebies*.

Rosh Ashana, the name of the beginning of the Jewish year.

From the same conception of unlawful days, the rule directs that there should be no observance of the new Moon of *Thiersi*, which marks the beginning of the *Civil* year (called *Rosh Ashana*) when it falls on the 1st, 4th or 6th feria of the week; for in such a case the festival of the *Tabernacles* cannot be celebrated as usual, and as *Whit-sunday*, or *Pentecost*, is the 50th day after *Easter*, and must consequently fall on the feria next to that of *Easter*, the holy day alluded to is not to be kept on either the 3d, 5th or 7th day of the week.

How to find which is a deficient, mean or redundant year.

When the lawful day or *Kebis* on which the year is to begin, has been determined, the Jews find whether it be a common, or an intercalary year, and at the same time (whichever of these it may prove) whether it be a deficient, mean, or redundant one, of its sort, in the following manner.

PRECEPT 1.

Precept for a common year.

“ Subtract the *Kebis* of the proposed year from that of the following one, and if the latter be less than, or equal to the former, add 7 days thereto: and if the remainder be 3, 4 or 5, the current year is a common one. Furthermore, it is deficient, mean, or redundant, as these numbers are increasing from 3 to 5.

PRECEPT 2.

Precept for an embolismic year.

“ But if the remainder be 5, 6 or 7, then the proposed year is embolismic. Moreover, it is deficient, mean, or superabundant, as these numbers are increasing from 5 to 7.”

N. B.—The three sorts of years of each kind, consist of the following number of days.

Of the common,—the deficient is 353^d; the mean 354^d; the redundant 355 days.

Duration of each.

Of the embolismic,—the deficient is 383^d; the mean 384^d; the redundant 385 days.

EXAMPLE 1.

Examples.

Let the *Kebis* of any proposed year be 3, and that of the following one 7; if we subtract the

former from the latter, the remainder will be 4; which, according to the preceding rule, shows that the given year is a common one; and of that sort, a mean year.

Examples.

EXAMPLE 2.

But if the Keble of the proposed year be 5; and that of the ensuing one also 5; then $5+7=12$; and $12-5=7$, which shows that the current year is embolismic, and also a redundant year.

Q. E. D.

Table exhibiting the names of the Jewish months, and the duration of each sort of years and months, whether deficient, mean, or redundant.

Common Jewish years.					Embolismic years.				
Names of Jewish months.	Years.			Corresponding Julian months.	Names of Jewish months.	Years.			
	Deficient.	Mean.	Redundant.			Deficient.	Mean.	Redundant.	
	Days.	Days.	Days.			Days.	Days.	Days.	
1 Nisan, or Abib	30	30	30	March April	1 Nisan	30	30	30	
2 Ijar, Isar, or Zius	29	29	29	April May	2 Ijar	29	29	29	
3 Sieban, or Sivan	30	30	30	May June	3 Sieban	30	30	30	
4 Thamuz	29	29	29	June July	4 Thamuz	29	29	29	
5 Ab	30	30	30	July August	5 Ab	30	30	30	
6 Elul	29	29	29	August Septem.	6 Elul	29	29	29	
7 Thiar, or Eshan	30	30	30	September October	7 Thiar	30	30	30	
8 Marheevam, or Bul	29	29	30	October Novem.	8 Marheevam	29	29	30	
9 Cisleu, or Casieu	29	30	30	November Decem.	9 Cisleu	29	30	30	
10 Thebeth	29	29	29	December January	10 Thebeth	29	29	29	
11 Shebeth, or Saabath	30	30	30	January February	11 Saabath	30	30	30	
12 Adar	29	29	29	February March	12 Adar	30	30	30	
				March	13 Ve Adar	29	29	29	
					(inter.)				
Sums of days	353	354	355			383	384	385	

25. *Luni-solar year of the Ancients.*—Montana, from whose History of the Mathematics the present article was extracted, has omitted to state in what country, and what people made use of this year, which he calls merely "Of the Ancients". His account of it is as follows:

Luni-solar year of the Ancients.

That year is grounded on a Cycle of 19 years, like that of Meton. Its mean duration is $354^{\circ} 8' 43'' 38' 11''$, &c. The Cycle was divided into 12 complete, and 7 incomplete years, which last they intercalated, so that their embolismic months fell on the 3d, 6th, 8th, 11th, 14th, 17th, and 19th of the Cycle, being the same in order as that of the Jews, and invariably followed through the ensuing Cycles, both differing from the method of the Indians, according to which the Epochs of intercalations are variable.

Again, as the Ancients found that 99 Lunar months (of $29^{\circ} 12' 43'' 38' 10''$, &c.) contained 2923 days and 12 hours, which in 60 years gave an excess over the Sun's mean motion of 3 days; and 30 in 160 years, they omitted at the end of that period, one of the intercalary months. The Luni-solar year of the Indians has in appearance a similar omission; but it must not be supposed to have the least analogy with the expunged month of the Ancients, 1^o Because the *Cakya* of the

Indians is not confined to 160 years, but may recur after 141 and 19 years; So Because, whereas the Ancients *really* retrenched one month, the Indians omitted *nothing*; the supposed Equation bearing entirely on the artificial duration of the year, the names and succession of their months.

The Chaldean Series
of Saturn.

20. The Chaldean Series, or Seasons.—Of this *Æra* I shall only observe that although some Gentlemen have fancied that it might have some affinity with the Cycle of Jupiter of 60 years, yet we hardly know more of it than its name. Halley considered it to be the period of 223 Lunar months, used at the time of, and even before Hipparchus, for computing the return of Solar Eclipses. But Delalande affirms, that it was a mistake which originated with *Suidas*, and is now entirely abandoned.

CHRONOLOGICAL TABLE.

Application of the Chronological Table.

After Christ.	Reform of the Calendar in England 29th March 1752.	1752
	Gregorian reformation of the Ka- lendar 4th October 1582.	1682
	Æra of Dioclesian or of the Mar- tyrs, year begins 29th August.	285
	Indian Æra of Salivahana, begins with the Hindu Solar year.	78
Indiction.		3
Epoch of the Indian Cycle of 60 years or Grahparivritthi, begins with the Hindu Solar year.		24
Iberian or Spanish, its year begins with the Julian year.		38
Cæsarian of Antioch, year begins in Au- gust.		48
Indian Æra of Vicramaditya, begins with the Hindu Lunar-solar year.		57
2d of the Seleucidæ, year begins 1st Sep- tember, but according to the Arabs 1st October.		312
Æra of Nabonassar, began 26th Feb.		746
Building of Rome, or Roman Æra.		762
Olympiads, year begins 1st July.		776
Indian Æra of Paravarma, begins 7th August 3537 of the Julian period.		1176
Indian Æra of the Cali yug, begins Friday 18th February 1612, Julian period.		1301
Referred to supposed Epoch of Creation.	Epoch of Creation according to Port Royal writers.	4004
	Epoch of Creation according to Hutton.	4007
	Julian period.	4713
	Ecclesiastical of Antioch.	5492
	Æra of Alexandria.	5502
	Æra of Constantinople, begins Civil 1st September, Ecclesiastical 21st March.	5508
Year of Christ complete, according to Dionysius Exiguus.		0

By means of this Table any year pro-
posed according to either of the Indian
accounts, may be referred to the corres-
ponding one of any other Æra therein
registered.

For let the proposed year be expressed
according to the style of the *Æras Cali
yug, Vicramaditya, or Salivahana*; the
same may be reduced to Christian account
by adding 3101 to the first, 57 to the se-
cond, and by subtracting 78 from the third.

Having thus found the Christian year
answering to that proposed in any of the
three principal Indian accounts, if you
want the concurring one of any other Æra,
the Epoch of which ascends to any period
before Christ, you have the following Pre-
cept.

PRECEPT 1.

“To the year of Christ, found as above
“directed, add that given in the Table for
“the Æra referred to, and the sum will
“give the year sought.”

For Epochs which fall after Christ.

PRECEPT 2.

1^o If the Æra in which the year is
sought begins before Christ,

Concurrence of Chronological Epochs at the birth of Christ, and Epochs of subsequent events referred to
A. D. 0 complete.

For Epochs before
Christ.

For Epochs after
Christ.

" To the proposed Indian year, *add* its proper Epoch, the sum gives the Christian year ; and
 " to the latter *add* the Epoch of the *Æra* sought, the sum gives the corresponding year (in that
 " *Æra*) to the proposed Indian year."

When the Epoch
falls before Christ
and the year sought
after.

2^o. If the *Æra*, the year of which is sought, as well as the proposed one, begins *after* Christ.

When both fall after
Christ.

" To the proposed Indian year, *add* its proper Epoch, and from the sum, *subtract* that of the
 " *Æra* sought, the remainder gives the year in the same, which answers to the proposed one."

EXAMPLE I.

Let the year 4023 of the Cali yug complete, be proposed.—Wanted the year of the Julian period corresponding thereto?

Examples.

By Precept we have	-	-	-	4023
				- 3101
				1922
				+ 4713
Year of the Julian period sought				<u>6535</u>

Year of the Cali
yug into that of the
Julian period.

EXAMPLE II.

Let the year Vicramaditya 1879 be proposed ; then $1879 - 57 + 4713 = 6535$, the same as in the first Example ; whence we conclude that the year of the Julian period 6535 answers to the end of the 4023d year of the Cali yug, and the 1879th of Vicramaditya.

EXAMPLE III.

Let the same be proposed for the year 1744 from the birth of Saliwahana. Then by Precept, $1744 + 78 + 4713 = 6535$ of the Julian period.

Year of Saliwahana
into the same.

But if instead of the corresponding year of the Julian period, we required that of the *Æra* of the Martyrs, the Epoch of which is 286 years *after* the year of Incarnation O; we shall have by Precept $1744 + 78 - 286 = 1536$, the corresponding year of the *Æra* sought.

The converse of these rules is so evident, that it requires no Examples ; all that need be added is, that on the above principles, the years of the Cali yug 4023, of Vicramaditya 1879, and Saca 1744, will be found to answer to years of different *Æras*, as follows :

To that of Constantinople	-	-	-	-	-	7330
of Alexandria	-	-	-	-	-	7324
Ecclesiastical of Antioch	-	-	-	-	-	7314
of the Julian period	-	-	-	-	-	6535
of the World	-	-	-	-	-	6826
of Nabonassar	-	-	-	-	-	2568
of the Iberian	-	-	-	-	-	1860
of the Martyrs	-	-	-	-	-	1536
&c.						

The Hindu year re-
ferred to different
Epochs.

There remains to consider the Indian *Æras* which are subject to Cycles, such as the *Grahaparivritih* of 90 years, and *Vrikasputi* of 60 years.

Æras subject to Cy-
cles.

As the former are merely Solar years, as well as the latter, when computed according to the Tellings account, the process for finding the more abstract concurring years is the same as that above explained. But if we consider these when expressed by a specific name, or by cycles and years, the case no longer applies. Thus if we want merely the year of the *Grahaparivritih* which

The Grahapari-
thi, or Cycle of 90
years.

expired in A. D. 1822, we need only add 24 thereto, and it will be 1846, so that referring to Examples I and II, the year of the Julian period corresponding thereto will be 6535, as before.

But if the number of cycles and years expired be given, which would be found by $\frac{1822+24}{60}$
= 20 cycles, 46 years complete, or 21° 47' current, that expression must be decomposed before referring it to any year of another Aera.

The Vrihaspati or
Cycle of 60 years.

According to the
Tellinga.

In the same manner the years of the Vrihaspati-Chakra, by the *Tellinga* account, are always presented either by names or numerals; and the Chakra year corresponding to A. D. 1822, would be elicited by $60 \div 4923 (82^{\circ} 3')$ expired; and the remaining three years counted from *Pramathi*, (the 13th of the Chakra) as zero, would give *Chitrabhanu* the 16th of the Cycle, for the name of the current year; so that by a circuitous road, that of the Cali yug to which it corresponds might be discovered, and the rest would follow.

According to the
Siddhantas.

The same thing may also be said of the year of the Chakra, when referred to the mean heliocentric motion of Jupiter, which seems still more irreducible, than the *Tellinga*, when proposed only by its name, and number of cycles expired.

The year of Jupiter which answers to any year of the Cali yug, according to the account of the *Suriah Siddhanta*, may always be found, by a very simple process, the particulars of which were given in a Postscript to the third Memoir of this collection, and which for the same year 4923, will elicit *Pijaya* the 27th of the cycle.

When the Epoch is known within 60 years, and the specific name of the current Vrihaspati year is given, then the concurring year of the Cali yug may be discovered by means that were indicated in the second Appendix.

NOTE.

I have not been able to discover upon what authority Dr. Hutton places the Epoch of the Creation of the world in A. A. C. 4007, as he does in the Chronological Table which he has published in his Mathematical Dictionary, vol. I, page 434. For independently of the *Port Royal* writers, who have fixed it in A. A. C. 4004, I find the following passage in *Voiron's* continuation of *Bailly's Astronomy*.

" La Place determine deux Epoques Astronomiques tres remarquables; la premiere par la coincidence du grand Axe de l'orbite terrestre avec la ligne des Equinoxes; la seconde par sa position perpendiculaire sur cette ligne.—il fait remonter la premiere a l'an 4004 avant Jesus Christ, *tous ou la plupart des Chronologistes placent la Creation du monde*; la seconde a l'an 1250 de l'Ere Chretienne." Page 197.

Notwithstanding these testimonies, Dr. Hutton's authority is too respectable to be laid aside, without knowing upon what ground he has decided the question; and on that account I have preserved his Epoch in the Table inserted at page 302.

APPENDIX IV.



ON THE
HINDU EPHEMERIDES.

APPENDIX IV.

Giving some account of the Hindu Ephemerides and of the subsidiary articles of the Kalendars.

THE Solar and Luni-solar Kalandars contain each the same articles, but differently arranged; and as the former is computed by the Solar, or *Vakiani*, process; whereas the latter follows the Sydercal rules of the Surriah Siddhanta, there is a difference in the results which may sometimes amount to six hours of time. As for the rest, the explanation of the contents of one, is perfectly sufficient for understanding those of the other.

Of the Ravi Panchangum.

The Solar Kalendar, independently of the months and civil days, which (like all others) it registers, gives also the time when the most remarkable phenomena occur.

The Solar Kalendar.

The word Panchangum implies five articles, which are permanently inserted in its margin; but besides these, there are several others, which, not being *Ephemeral*, appear of course only when occasion requires it.

The margin of the Solar Kalendar always opens with an accessory article, independent of its year, but intimately connected with the moral habits and superstitions of the Hindus. It registers the name of, and the time when, the Tidhi which is coupled with any Solar day in the year, terminates: It also notices in what Parsha (the demi-lunar corresponding month) the time is running; and lastly, when a Tidhi is repeated, or expunged out of the Chandra Panchangum.

Its contents.

The permanent articles, as we have stated in article 2 of the Key to the Siddhanta Chandra-mana (page 73), are

Five permanent articles.

1^o The name of the Nacshatra in which the Moon happens to be on any particular day; with the time of her passing to the next.

The Nacshatra in which the Moon happens to be.

2^o The Yogh (an Astrological Element) or the space of time during which the *sum* of the Sun and Moon's motion, amounts to one Nacshatra, or 13° 20', with the time when that Arc is completed.

The Yogh.

3^o The Curna (another Astrological Element) or space of time during which the Moon's motion from the Sun amounts to 6°, there being two Curnas in a Tidhi, and the Kalendar registering the time of its ending.

The Curna.

4^o The Thyajum or Thyagum of the Wurjum (another Astrological Element), being the unlucky

The Thyajum of the Wurjum.

period of the day, the mean duration of which is about 4 guddias (1^h 36' European time), pending which all voluntary business of importance ought to be suspended; marking the time of its beginning.

When the Wurjum occurs at day time, it is called *Devi*, and when at night *Ratree*.

The Isharum or
Teharum.

5^o The Isharum or Teharum; being an account of the position of the Planets, (including Rahu ☊ and Ketu ☋) on any day in the year; and the time when either of them enters any of the four quarters, or Padahs, of a Nacshatra; marking thus the time of their position at every 3° 20' of the Lunar Zodiac.

Rahu ☊ and Ketu
☋ considered as
Planets.

N. B.—Whenever the Planets are mentioned in the following statement, it is always to be understood that the Moon's ascending and descending Nodes are considered to be of the number, according to the Hindu notions, which account for the Eclipses, in a physical sense, by supposing these to be obscure Planets.

Accidental articles.

The accidental articles are partly Astronomical, and partly Astrological, like the permanent ones; and are as follows:

Rahu and Lower
Eclipses; the Sun in
the Equinoxes or
Solstices, and enter-
ing a new Sign.

1^o The Solar and Lunar Eclipses; the time when the Sun is in the Equinoxes or the Solstices (*Mesha Ayana*, *Tula Ayana*, meaning the Equinoxes; *Vatsha Ayana*, *Detchana Ayana*, the Solstices); and also the time of his entering a new Sign.

The Crantum.

2^o The *Crantum* (an Astrological Element). I have been at some pains to understand distinctly the nature of this article, as well as that of the *Vethai*, which is connected with, and follows it; and I am not without some doubts whether after all, I have construed either accurately. What follows is therefore, the best that I could make out of the account given to me of both by my instructor.

The literal meaning of *Crantum*, is *overpowered*; and that of any Planet, is when it is in conjunction with, or is overpowered by, the Moon; which consequently implies, that the time of new Moon is the Sun's *Crantum*.

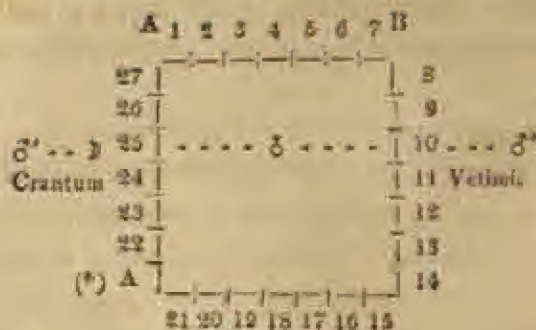
Mars, Saturn, Rahu ☊ and Ketu ☋, have a bad influence in *Crantum*, and mark unlucky days. The other Planets have also their *Crantums*, but being innocuous, they are not noticed in the *Panchangam*.

The Vethai.

3^o The *Vethai* (also an Astrological Element). The literal meaning of this word is to *break*, to *cleave*, or to *corrupt*. The *Vethai* is determined by the Planet to which it refers, being in opposition to the Moon in a particular arrangement of the Lunar Zodiac; which certainly does not imply in all cases a real opposition in the Heavens; it is supposed to be the converse of the *Crantum*, and to partake of its good and bad influences and qualities.

The construction of
the Crantum and
Vethai explained.

The Native Astrologers use a Diagram to explain these phenomena, of which here follows a representation.



Let the 27 regular Nacshatras, together with the Abhijit (*) or extraordinary one, be disposed in a square, each side of which contains seven Nacshatras. Let the Earth stand somewhere in the interior of this square, and conceive the Planets to revolve around it, the Moon being the nearest to the Earth. The magical square so constructed, is called *Sarvato Bhadra Chakra*.

Now the day on which the Sun or Planet is in a Nacshatra with the Moon on a line with δ , δ' , is the *Crantum* of the Sun or Planet referred to.

But, (every thing besides remaining as before) if the same Planet, instead of being in δ' , happens to be in δ'' in a Nacshatra as far distant from B, as δ is of A, then it is in *Vethel*.

Thus if A represents the Nacshatra *Ashvini* (the 1st), and the Moon be in the third before A, i. e. in *Purva Bhadrapada* (the 25th), and if the Planet *Mars* appears from the Earth in the latter Nacshatra on the same day, then it is overpowered, or in *Crantum*.

But if at the time that the Moon is in three Nacshatras behind A, *Mars* is in three Nacshatras before B, or which is the same thing in ten before A, (which in the present supposition will be *Mazha*), then δ'' is in *Vethel*, or corrupted.

It needs no great reflection to perceive that such a scheme belongs neither to regular Astronomy, nor Astrology; but avours more of the art of magic than any thing else: for even Astrology, where it is connected with Astronomy, is symmetrical; and uses regular constructions, even though its ultimate object be fantastical.

Here on the contrary, we see the extraordinary Nacshatra *Abhijit*, which contains only an Arc of 5° ($3^{\circ} 20'$ of which it borrows from *Uttara Ashadha* the 21st, and $1^{\circ} 40'$ from *Sravana* the 22d, so as to leave the Lunar Zodiac to consist, as before of 360°) reckoned in the magical square as an entire and additional one of $13^{\circ} 20'$. And again, if the Moon happens to be at the top or bottom of the square, and a Planet be in *Vethel*, so far from the line which passes through the Moon; the Earth and the Planet, dividing the Heavens into two equal parts, (as an opposition implies) it cleaves it in two segments of 21 and 7 Nacshatras each.

In either cases of the *Crantum* or *Vethel*, *Mars*, *Saturn*, *Rahu* ☊ and *Ketu* ☋, have an evil influence; and therefore, no marriage ceremony, nor any other of rejoicings ought to be performed. But the *Shradham*, or ceremonies for deceased ancestors, or relatives, may go on as usual.

4. The *Latta* (also an Astrological Element). This word literally means *struck*, *kicked*, The *Latta*, and like the former, has its application to the concerns of mankind.

There are two sorts of *Lattas*, viz. the Eastern and the Western; those of the Sun, Mars and Saturn, being accounted East, and of Rahu ☌ and Ketu ☌ West.

The conception of this fanciful Element is as follows:

Manner of computing the moon,

Whenever the Sun is in 12 Nacshatras (the other Planets have a different scale) counted Eastward from that in which the Moon happens to be, then it is *Latta* or struck. Mars, and Saturn's *Lattas* are also East, but they are struck, the former in the 9th, the latter in the 3d Nacshatra from that of which the Moon is in possession. On the contrary, Rahu ☌ and Ketu ☌ (because I suppose their motion is retrograde) are kicked in the 8th and 9th Nacshatra from the Moon, on the West. The other Planets not mentioned in the above list, have also their turn of chastisement, but as they bear it patiently, and do not repeat it on mankind, no notice is taken of it in the Panchangum.

When the *Latta* is accounted East, the Nacshatras are to be counted from the Moon, according to their order in the Lunar Zodiac; and when West, contrary to it. Thus, for example, if we suppose the Moon in the Nacshatra *Swati* (the 15th) and if the Sun be in *Uttara Bhadrapada* (the 28th among the regulars, but the 27th on account of the *Abhijit*), then it is *Latta*. But if Rahu ☌ be at the same time in *Pusha* (the 7th in the Zodiac, and as the Moon is supposed to be in the 15th, the 8th from the Moon), then it is also *Latta*.

The days on which the *Grantam*, *Felket*, and *Latta* fall, when referred to the Sun, Mars, Saturn, Rahu and Ketu, are baneful days.

This critical circumstance, which can only occur once in a month for each of the above mentioned Planets, imposes the same restrictions as the *Grantam* and *Felket*.

Such are the principal Astronomical and Astrological articles of the Indian Ephemeres; which I have endeavoured to understand, and explain, in order to shew the cause of those pretences of religious and moral inhibitions, under the screen of which the Natives of all classes postpone business, or neglect their duties, often to the great inconveniency of the public service, but more particularly of that of private individuals. (*)

Besides the articles above particularised, the Panchangum exhibits a variety of notices which refer principally to religious observances: Such are the birth days, accessions, and anniversaries of memorable events and feats of certain gods, goddesses, spirits, patriarchs and other worthies; including the anniversaries of the beginning of the Calpa, Manwantaras, Mahayuga, and of the four lesser Yugs of the Manwantara in which we live.

Anniversaries generally observed.

The anniversaries which are more particularly specified, are those of the ten incarnations of Vishnu; those of the *Gowries* (certain female spirits or genii on which the *Vritum* or solemn fast is to be kept) and the accession of the patriarchs, fourteen in number; which are supposed

(*) There is an opinion among a certain set of Brahmins, that in those Lumbantar years where two months are repeated, and one is expunged, no religious ceremony ought to be performed during the first intercalated Lunar month of the mid year. This proposition having been argued in the year 1822 (which presented a case to point) in a full assembly of Brahmans and Pandits at Madras, was condemned as heretical; and the Brahmin who supported it was excommunicated.

to preside successively over the fourteen Manwantaras (3084480000) which, with the *Sandhya* or twilight (172800000) constitute the *Calpa* (4320000000).

It is the opinion of some divines, that the *Calpa* formerly consisted only of nine Manwantaras, each of which contained, as at present, 71 Mahayugas; but as it does not enter into the plan of this article to enter into the Cosmogony or Theology of the Hindus, I only mention it with a view to a few remarks on the names of the fourteen patriarchs or Manus, whose anniversaries are now kept, and whose names I shall give, because they are little known; stating at the same time, the Lunar months, Panchas, and Tithis on which they are respectively observed.

The 14 Manus.

Names and number of Manus.		Tithis on which observed.		Lunar months.	Panchas.
		Numeral.	Names.		
1	Swáyambhūva	12	Dwadasi	Cariga	Sucha.
2	Svarūchika	9	Navami	Asvina	Do.
3	Uttama	3	Tritia	Chaitra	Do.
4	Tāmasa	3	Tritia	Chaitra	Do.
5	Rayvata	11	Yekadasi	Pausha	Do.
6	Ishwara	10	Dasami	A'shād'ha	Do.
7	Vayanasvata	17	Septami	Magha	Do.
8	Brahma Sāvarni	15	Pachami	Phalgunā	Do.
9	Rodra Sāvarni	8	Asami	A'shād'ha	Christma.
10	Daśha Sāvarni	8	Asami	Chaitra	Do.
11	Agni Sāvarni	30	Amāvasya Th.	Srawana	Do.
12	Sūrya Sāvarni	8	Asami	Chaitra	Do.
13	Rouchya	15	Pournami	Chaitra	Sucha.
14	Bhrouhya	15	Pournami	Jyāshthā	Do.

Among the names of the patriarchs, it is remarkable that five bear the additional one of *Sāvarni*; that the name of the 8th is *Brahma*, the 9th *Rodra* (the same as *Siva*), and that the 13th bears the name of the Sun. Whether *Daśha* the 10th refers to *Vishnu*, and *Agni* the 11th to the Moon, I do not pretend to know; but this seems possible, from the quality, and arrangement of the five which bear the cognomen of *Sāvarni*. If so, it would be a strong indication that (since three bear evidently no patriarchal names) the whole have been interpolated.

Remark on their number and names.

The remaining anniversaries, as has already been stated, are those of the ten incarnations of *Vishnu* (*) and of the *Gowries*, on which the *Pratham* is kept; but I am not sufficiently versed in Hindu Mythology, nor have I space enough at command, to give a specific account of their nature, names, and dates of observance.

The 10 incarnations of Vishnu.
Facts of the Gowries.

(*) There are ten names under which *Vishnu* appears in the *Kalāndar*, viz. 1. Matsyagōra, 2. Chakora, 3. Varaha, 4. Narasimha, 5. Vamana, 6. Parasurama, 7. Sri-rāma, 8. Kāshyapa, 9. Sri-krishna, 10. Kali or Calki, according as he assumed the aspect of a Fish, a Tortoise, a Wild Hog, a Dwarf, a Brahmin, a Cabotia, a Shepherd, and a Horse with a human face. Of the *Gowries*, I am told the number is considerable.

Local holy days.
Fests of the principal
pagodas in the
neighbourhood.

The Panchangum also notices the local holy days, and the feasts of the most considerable pagodas, situated about 100 miles around the place for which the Kalendar is computed ; besides other items of a religious, or superstitious nature (for even an idolatrous religion may know these distinctions), which will be easily understood when met with in the Kalendar, and therefore need not be enumerated.

Civil articles.

Duration of the
artificial days and
nights.

Prediction of abun-
dant and scarcity.

Rural occupations.

Lastly : There will be found in the margin of the Panchangum certain articles of a civil description, such as the length of the artificial solar days, and nights, indicated at least once in the course of the month ; the Sun's entrance into the different Signs of the *Tropical Zodiac*, and those predictions, of abundance (*Prithivarga*), middle state of prosperity (*Samarga*), and of scarcity (*Shookiarga*), intended to point out the proper seasons for rural occupations ; just in the same manner as these contingencies were formerly announced in a far famed Almanac, published at Liège, under the fictitious name of *Mathieu Lamberg*, which sold for six pence throughout the Continent of Europe, and might have vied with, and perhaps excelled, the Indian Patras, in the absurdity of its articles.

NOTE.

All the articles of the Hindu Ephemerides inserted in the Patras, are given in an abridged form ; and are so contracted, that what fills five pages in the translation, is contained in one of the original. In the Peninsula, the *Ravi Panchangum*, is generally published in the *Tamil* idiom ; and the *Chandra Panchangum*, in the *Telugoo* ; on which account they are known by the name of the *Tamil*, and *Telugoo Kalendar*.



A translation of the first page of the Tamul Solar Kalendar (Ravi Panchangam) for the year of the Caliyug 4926 current, answering to A. D. 1824, computed in Solar time and with the Elements given in the Aria Siddhanta for the Latitude and Meridian of Fort St. George.

Years of the Caliyug elapsed 4925. From the birth of Salivahana 1746. Of the Æra Vicramaditya 1881. Of the Vrihaspati Chakra, Tellinga account, Tarana (the 18th). Do, Benares account, Manmat'ha (the 29th). Of the Grahaparyvriti or Cycle of 90 years, the 48th.

KALENDAR.

MONTH CHAITRAM (Bengal Vaisâkha).

Ephemerides.

European date, April.	Tithi or Tamul date.	Feix.	
11	1	Sunday.	Triodesi (the name of the concurrent Lunar Tithi) it's end 47 ^h 20 ^v (after apparent time of Sun rising) — \mathfrak{P} in Nacshatra Purva Phalguni, passes to the next at 2 ^h 33 ^v . — Yagû Vridhî (the 11th) ends at 2 ^h 50 ^v . — Do. Dhruva (12th) ends 53 ^h 5 ^v . — Curma Coulava (the 3d) ends 10 ^h 50 ^v . — Thyagum of Warjuna, Devi (day time) begins at 20 ^h 41 ^v . — Mesha Vishuvat (indicating that certain religious ceremonies which depend on the recurrence of the Vernal Equinox are to be performed. — Samarga (mean state of agricultural prosperity — time proper for sowing the fields) — Ahna (or Dinarda duration of the artificial day) 30 ^h 40 ^v . — Mercury enters the second Padah (quarter) of Nacshatra Aashlâ at 51 ^h . — Jupiter enters the third Padah of Nacshatra A'rdrâ 16 ^h . — Mars' Crantum in Nacshatra Purva Phalguni (no marriage ceremonies on account of the Crantum). — The Sun and Rahu (\mathfrak{P} & \mathfrak{R}) are Latta — Sooniâ (state of unfavourable prospects) no Srardum (ceremonies for deceased ancestors) — Madonna Triodesi (the last day of a festival begun before).
12	2	Monday.	Chaterdashî, ends at 42 ^h 55 ^v . — \mathfrak{P} in Nacshatra Uttara Phalguni, ends at 0 ^h 23 ^v . — passes on the same Tithi into Nacshatra Hastâ, ends 57 ^h 52 ^v . — Yagû Vyagatha (12th) ends 42 ^h 45 ^v . — Curma Garujah or Yurha (5th) ends 16 ^h 6 ^v . — Thyagum of Warjuna, begins 21 ^h 34 ^v . — Venus enters 1st Padah (quarter) of Nacshatra Uttara Bhadrâpada 15 ^h . — No ceremonies allowed on this day.
13	3	Tuesday.	Purnima Tithi (day of full Moon), ending at time of apparent opposition, which occurs at 30 ^h 16 ^v . — \mathfrak{P} in Nacshatra Chitra, end 56 ^h 26 ^v . — Yagû Hersama (13th) ends 44 ^h 5 ^v . — Curma Bhadra (7th) ends 11 ^h 5 ^v . — Thyagum of Warjuna, Devi (day time) begins 17 ^h 30 ^v . — Mercury enters 3d Padah of Nacshatra Aashlâ at 41 ^h . — Mars is Latta — Accession of Rouchya Manu (one of the fourteen presiding spirits of the

CALENDAR.		
European Date, April.	Thirudi or Tamil date.	Week.
14	4	Wednesday.
15	5	Thursday.
16	6	Friday.
17	7	Saturday.
18	8	Sunday.
19	9	Monday.
20	10	Tuesday.
21	11	Wednesday.

*Paisācha, or Chaitram, continued.**Epemerides.*

Calpa divided into 14 Manwantaras)—Chaitra Purnima (day of full Moon in Chaitram) a Tithi of general observances and ceremonies.

Christna Paksā (the dark half of the month) Padyami (1st Tithi of the said Paksā) ends 30x 41x— γ in Nacshatra Swati, ends 55x 50x—Yogā Vajra (15th) ends 30x 43x—Curna Bhalava (2d) ends 7x 53x—Thyagum of Wurjum, Devi (d. t.) begins 10x 18x—Sun enters 2d Padah of Nacshatra Aświni 10x 21x—Venus enters 2d Padah of Nacshatra Uttara Bhādrapada, 58x—Saturn enters 3d Padah of Nacshatra Kritikā 34x.

Dulita T. ends 35x 0x— γ in Nacshatra Visākhā, ends 56x 24x—Yogā Siddhi or Asrij (16th) ends 35x 20x—Curna Dhātala (4th) ends 5x 51x—Thyagum of Wurjum, Devi (d. t.) begins 9x 55x—Mercury enters 4th Padah of Aświni 34x.

Tadiya T. ends 34x 41x— γ in Nacshatra Anurādhā, ends 58x 13x—Yogā Vyatipātā (17th) ends 34x 24x—Curna Warnaji (6th) ends 4x 51x—Thyagum of Wurjum, Devi (d. t.) begins 6x 42x—Garoolarahana, Triplicane feast.

Chouti T. 55x 42x— γ in Nacshatra Jyēsthā, ends 60x—Yogā Variyās (18th) ends 30x 22x—Curna Bhāva (1st) 3x 11x—Thyagum of Wurjum, Devi (d. t.) begins 12x 56x—Sun enters 3d Padah of Nacshatra Aświni 39x 52x—Mercury enters 1st Padah of Bharani 25x—Venus enters 3d Padah of Nacshatra Uttara Bhādra 41x.

Punchami T. ends 37x 50x— γ in Nacshatra Jyēsthā ends 1x 17x—Yogā Parigha (19th) 20x 15x—Curna Coulava (3d) ends 6x 40x—Thyagum of Wurjum, Devi (d. t.) begins 22x 42x—Matsya desā (anniversary of Vishnu's incarnation as a Fish).

Shusti T. ends 41x 10x— γ in Nacshatra Mula, ends 5x 36x—Yogā Sira (20th) 20x 35x—Curna Garujah (5th) ends 9x 30x—Thyagum of Wurjum, Devi (d. t.) begins 1x 20x—2d Thyagum, Rātri (night time) begins 0x 47x—Mercury enters 2d Padah of Bharani 10x.

Septami ends 45x 30x— γ in Purva Aśād'hā, ends 10x 53x—Yogā Siddha (21st) ends 20x 22x—Curna Bhādra (7th) ends 13x 20x—Thyagum of Wurjum, Rātri (n. t.) begins 1x 55x—Mercury visible, West 26x—Venus enters 4th Padah of Nacshatra Uttara Bhādrapada 24x—Rahu (γ 's 33) Conjunct in Nacshatra Purva Aśād'hā.—*Rahat Sarum*, feast of the great chariot in Triplicane.

Asumi T. ends 50x 16x— γ in Nacshatra Uttara Aśād'hā, ends 16x 53x—Yogā Sadhya (22d) ends 31x 32x—Curna Bhalava (2d) ends 17x 53x—Thyagum of Wurjum, Devi (d. t.) begins 27x 58x—Sun enters 4th Padah of Nacshatra Aświni 6x 10x—Sun also enters the Tropical Zodiacal Sign Vrisāha δ at 14x 55x—Mercury enters 3d Padah of Nacshatra Bharani at 12x—Ahas (duration of artificial day) 31x.

CALENDAR.			<i>Falgun, or Chaitram, continued.</i>	<i>Ephemerides.</i>
European date, April.	Tithi or Tansil date.	Festiv.		
22	12	Thursday	Navami T. 55 ^h 17 ^m .— γ in Nacshatra Sravana 23 ^h 15 ^m .—Yogâ Subha (23d) 35 ^h 0 ^m .—Carna Dhitala (4th) 42 ^h 45 ^m .—Thyagum of Wurjum, Ratri (night time) 35 ^h 20 ^m .—Sattrica Vethai (no marriage ceremonies).	
23	13	Friday	Desami T. 60 ^h .— γ in Nacshatra Dhanishthâ 20 ^h 45 ^m .—Yogâ Subha (24th) 34 ^h 20 ^m .—Carna Warnajee (5th) 37 ^h 47 ^m .—Thyagum of Wurjum, Ratri (night time) 18 ^h 27 ^m .—Mercury enters 4th Padah of Nacshatra Bharani 45 ^h .—Venus enters 1st Padah of Revati 7 ^h .—This Tithi (Desami) is Adigah, being repeated and called Triflora Sprohoo.	
24	14	Saturday	Desami T. 65 ^h 15 ^m .— γ in Nacshatra Satabhisha 35 ^h 42 ^m .—Yogâ Brahman (25th) 30 ^h 27 ^m .—Carna Bhudilava (7th, only <i>one</i> in advance from the last instead of two, on account of the day being repeated) 65 ^h 15 ^m .—Thyagum of Wurjum, Ratri (night time) 22 ^h 2 ^m .—Sun enters 1st Padah of Nacshatra Bharani 32 ^h 42 ^m .—Mercury enters 1st Padah of Nacshatra Critica 57 ^h .	
25	15	Sunday	Yodadesi T. 4 ^h 35 ^m .— γ in Nacshatra Purva Bhadrapada 41 ^h 3 ^m .—Yogâ Maha Indra (26th) 36 ^h .—Carna Bhalava (2d) 4 ^h 35 ^m .—No Thyagum of Wurjum. Venus enters second Padah of Nacshatra Revati 50 ^h .—Ketu, (γ 's γ) is Latta. A general fast, the men's foreheads to be painted according to castes.	
26	16	Monday	Duodesi T. 8 ^h 0 ^m .— γ in Nacshatra Uttara Bhadrapada 42 ^h 25 ^m .—Yogâ Valdrithi (27th) 25 ^h 30 ^m .—Carna Dhitala (4th) 8 ^h 0 ^m .—Thyagum of Wurjum, Devi (day time) 6 ^h 48 ^m .—Mars ceases to be retrograde and begins to proceed direct 42 ^h .—Mercury enters 2d Padah of Nacshatra Critica in Vrischa γ 56 ^h .—Varaha Jyanti's birth day.	
27	17	Tuesday	Triodesi T. 10 ^h 13 ^m .— γ in Nacshatra Revati 48 ^h 36 ^m .—Yogâ Vishcombha (1st) 34 ^h 43 ^m .—Carna Warnajee (5th) 10 ^h 15 ^m .—Thyagum of Wurjum, Devi (day time) 17 ^h 1 ^m .—Sun enters 2d Padah of Nacshatra Bharani 59 ^h 2 ^m .—Mars is Vethai (no marriage ceremonies; the Srandum or observance for the dead as usual).	
28	18	Wednesday	Chaturdasi T. 11 ^h 20 ^m .— γ in Nacshatra Aswini 50 ^h 32 ^m .—Yogâ Prithi (2d) 32 ^h 35 ^m .—Carna Soyami or Shakoni (9th) extraordinary 11 ^h 20 ^m .—Thyagum of Wurjum, Ratri (night time) 2 ^h 3 ^m .—Venus enters 3d Padah of Nacshatra Revati 33 ^h .	
29	19	Thursday	Amavasya or conjunction day (being the 30th Tithi of the Lunar month and the last or 15th of the Chaitra Pacsha) 11 ^h 10 ^m .— γ in Nacshatra Bharani 51 ^h 13 ^m .—Yogâ Ayushmani (3d) 29 ^h 25 ^m .—Carna Nayara (10th extraordinary) 11 ^h 10 ^m .—Thyagum of Wurjum, Devi (day time) 14 ^h 50 ^m .—Mercury enters 3d Padah of Nacshatra Critica 3 ^h .—Sun's Crantum in Nacshatra Bharani. On Amavasya or conjunction, a general observance of principal rites.	
30	20	Friday	Padyami or Prathama Tithi (1st of the Sucha Pacsha or enlightened half of the Lunar month) 2 ^h 42 ^m .— γ in Nacshatra Critica 50 ^h 53 ^m .—Yogâ Saubhagya (4th)	

KALENDAR.

European
date,
May.Tithi or
Tamil
date.

Feria.

*Falācha, or Chaitram, continued.**Ephemerides.*

MAY.

May
1

21

Saturday

22g 30r—Cerna Bhara (1st) 9g 46r—Thyagum of Warjuni, Devi (day time) 21g 8r—Saturn sets West 37g, his Crantum (no marriage ceremony)—This day is the 1st of the lunar-solar month of the Telingas—The Moon's crescent begins to appear this evening at Sun set, and the Mahomedan Civil month Ramzan commences.

Dutya or Vidya 7g 13r—J in Nacshatra Rohini 40g 42r—Yogū Sābhana (5th) 20g 32r—Cerna Conlara (3d) 7g 13r—Thyagum of Warjuni, Devi (day time) 30g 6r—Sun enters 3d Padah of Nacshatra Bharani 25g 45r—Mercury enters 4th Padah of Nacshatra Chitra 21g—Venus enters 4th Padah of Nacshatra Revati 16g—Trita yuga dina, or anniversary of the day on which the Trita yug began—Birth day of Balaram Deo.—*Astha* Tritya (the current Tithi), a lucky day.

2

22

Sunday

Tritya T. 3g 41r—The next Lunar Tithi, called Chouti, is a Cahaya or expunged one (and therefore intervening between Tritya and Panchami) ends at 85g 32r—J in Nacshatra Mrigashira 47g—Yogū Atiganda (9th) 14g 51r—Cerna Yurka (5th) the same as Garujee 3g 41r—Second Cerna (on account of expunged Tithi) VarnaJa (6th) 27g 16r—Thyagum of Warjuni, Devi (day time) 3g 5r—Ahur (duration of artificial day) 31g 15r—This is marked Aramaha on account of the expunged Tithi.

3

23

Monday

Panchami T. 64r—J in Nacshatra A'rdrā 43g 54r—Yogū Sucarna (7th) 2g 26r—Cerna Bhara (1st) 26g 37r—Thyagum of Warjuni, Devi (d. t.) 6g 52r—Mercury enters 1st Padah of Nacshatra Rohini 42g—Jupiter enters 4th Padah of Nacshatra A'rdrā 52g—Venus enters 1st Padah of Aashini in Mesha 7 59g—Ketu's (J's 8g) Crantum (no marriage ceremonies)—Sun's Vothai—Streepmadore feast—Yem-bramanna's birth day.

4

24

Tuesday

Shukla T. 48g 23r—J in Nacshatra Punarvasu 40g 14r—Yogū Dhriti (8th) 1g 31r—the next Yogū Sāla (9th) 52g 42r—Cerna Conlara (3d) 31g 12r—Thyagum of Warjuni, Devi (day time) 12g 4r—2d do. Ratri (night time) 27g 35r—Sun enters 4th Padah of Nacshatra Bharani 52g 14r.

5

25

Wednesday

Septimi T. 42g 52r—J in Nacshatra Pushya 36g 18r—Yogū Ganda (10th) 45g 38r—Cerna Garujee (5th) 15g 28r—Sheela (complement of) Thyagum 2g 54r—favourable day for marrying.

6

26

Thursday

Antami T. 36g 28r—J in Nacshatra A'sleshā 32g 16r—Yogū Vriddhi (11th) 39g 6r—Cerna Bhuddra (7th) 9g 30r—Thyagum of Warjuni, Devi (day time) 6g 10r—Mercury enters 2d Padah of Nacshatra Rohini 11g—Venus enters 2d Padah of Nacshatra Aashini 42g.

7

27

Friday

Navami T. 30g 30r—J in Nacshatra Maghā 28g 14r—Yogū Dhruva (12th) 31g 25r—Cerna Bhulava (2d) 3g 29r—Thyagum of Warjuni, Devi (day time) 6g 10r—2d do. Ratri (night time) 15g 36r—Saturn's Latta.

MAY.	KALENDAR.			<i>Vaisācha, or Chaitram, continued.</i>	<i>Ephemerides.</i>
	European date, May.	Theil or Tamil date.	Feriz.		
	8	28	Saturday.		
	9	29	Sunday.		
	10	30	Monday.		
	11	31	Tuesday.		

Desami T. 24s 46v.—) in Nacshatra Purva Phalguni 21s 25v.—Yogū Vyāghāta 24s 7v.—Carna Garnjee (5th) 24s 46v.—Thyagum of Warjūm, Rātri (night time) 10s 1v.—Sun enters 1st Padah of Nacshatra Criticā 18s 36v.—Mercury enters 3d Padah of Nacshatra Rohini 45s.—N. B. On Desami Tidhi the Srardua (ceremony for deceased ancestors) to be observed.

Yacadesi T. 10s 34v.—) in Nacshatra Phalguni 21s 8v.—Yogū Hershana (14th) 17s 10v.—Carna Budhrava (7th) 10s 34v.—Thyagum of Warjūm, Rātri (night time) 10s 35v.—Venus enters 3d Padah of Nacshatra Aswini 25s.—Saturn enters 4th Padah of Nacshatra Criticā 59s.—Mercury's Crantum—Rahu's ()'s 28) Latia.

Dundesī T. 16s 6v.—) in Nacshatra Hasta 18s 34v.—Yogū Vajra (15th) 10s 45v.—Carna Bhalava (2d) 16s 6v.—Thyagum of Warjūm, Rātri (night time) 6s 30v.—N. B. The ceremonies suspended on Tryadesi, the 1st day of this Solar month, (Mesha masa or month of Arica) to be performed on this day.

Tryadesi T. 11s 20v.—) in Nacshatra Chitra 16s 46v.—Yogū Aarj or Siddhi (16th) 5s 0v.—next Yogū Vyasipāta (17th) 54s 55v.—Carna Dhātala (4th) 11s 20v.—Thyagum of Warjūm, Devī (day time) 30s 34v.—Sun enters 2d Padah of Nacshatra Criticā, in the Solar Sign Vriśha 8 46s 47v.—Mercury enters 4th Padah of Nacshatra Rohini 27s.—Sun and Mars' Latia.—N. B. The ceremonies suspended on Chaturdesi to be performed on this day.

End of the Solar month Chaitram, or Vaisācha.



A translation of the first page of the Tellinga Kalendar (*Siddhanta Chandra mana*) for the Luni-solar year 4925 commencing, answering to the 1747th of the *Æra* of *Salivahana*; the expired years of the former being the 4925th, and of the latter the 1746th; and of the *Æra* *Vicramaditya* the 1881st, all corresponding to the year of Christ 1824. The name of the current year of the Cycle of 60 (*Vrihaspati*) being *Tarana*, according to Tellinga account; and *Maumatha*, *Benares* reckoning. Computed with the Elements of the *Surriah Siddhanta* for the Meridian and Latitude of Fort St. George.

KALENDAR.

European date, March.	Solar date, Tamil Poongoni or Chaitram.	Chaitra, Luni-solar date.	Feria.	Lunar Month <i>Chaitra</i> , the first of the Luni-solar year. <i>Epäemerides</i> .
				Sucha Pancha, or enlightened half of the month.
31	20 Tropical Zodiacal Sign Me. γ	1	Wednes.	End of Tithi 30 \times 3 ν .—Moon in <i>Nacshatra Revati</i> , passes to the next at 27 \times 31 ν .— <i>Yogä Maha Indra</i> (26th) ends 14 \times 18 ν .— <i>Curna Khimostogana</i> (11th) ends at 5 \times 43 ν .—No <i>Thyajum</i> of <i>Wurjum</i> .—Sun enters 2d <i>Padah</i> (quarter) of <i>Nacshatra Revati</i> , at 40 \times 34 ν .—Sun's <i>Crantum</i> .—Mars' <i>Veithi</i> .—Annual fast of <i>Samvatsara Gowry Vriham</i> (bathing and other rites).
April 1	21	2	Thursday	End of Tithi 36 \times 18 ν .—Moon in <i>Nacshatra Aswini</i> , passes to the next at 29 \times 30 ν .— <i>Yogä Vaidhriti</i> (27th) ends 12 \times 13 ν .— <i>Curna Bhalaria</i> (2d) ends 6 \times 11 ν .— <i>Thyajum</i> of <i>Wurjum</i> , 1. <i>Devi</i> (day time) begins 19 \times 11 ν . 2. <i>Ratri</i> (night time) 23 \times 2 ν .— <i>Mercury</i> enters 4th <i>Padah</i> of <i>Nacshatra Uttara Bhadrapada</i> , at 15 \times .— <i>Venus</i> enters 1st <i>Padah</i> of <i>Nacshatra Purva Bhadrapada</i> at 22 \times .—Duration of the artificial day, (<i>Dia Arda</i> , <i>Sungscrete</i> ; <i>Ahus</i> , <i>Tellinga</i>) 30 \times 20 ν .
2	22	3	Friday	End of Tithi 35 \times 17 ν .— p in <i>Nacshatra Bharni</i> , passes to the next at 30 \times 15 ν .— <i>Yogä Fishcambha</i> (1st) ends at 9 \times 7 ν .— <i>Curna Dhutala</i> (4th) ends 5 \times 48 ν .— <i>Thyajum</i> of <i>Wurjum</i> , none.—Accession of <i>Uttama Manu</i> (Patriarch).— <i>Vriham</i> or fast of <i>Gowri Sow baghla</i> .
3	23	4	Saturday	End of T. 33 \times 6 ν .— p in <i>Nacshatra Critica</i> 29 \times 50 ν .—1. <i>Yogä Prithi</i> (2d) 48 \times 52 ν . 2. <i>Yogä Ayushmat</i> (3d) 53 \times 7 ν .— <i>Curna Warnjee</i> (6th) 4 \times 11 ν .— <i>Thyajum</i> of <i>Wurjum</i> , <i>Devi</i> begins 0 \times 3 ν .— <i>Mercury</i> enters 1st <i>Padah</i> of <i>Nacshatra Revati</i> 2 \times .—Saturn's <i>Crantum</i> .
4	24	5	Sunday	End of T. 29 \times 50 ν .— p in <i>Naca. Rohini</i> , passes 28 \times 25 ν .— <i>Yogä Saubhagya</i> (4th) ends 54 \times 10 ν .— <i>Curna Bhara</i> (1st) ends 1 \times 27 ν .— <i>Thyajum</i> of <i>Wurjum</i> , <i>Devi</i> begins 8 \times 54 ν .—Do. <i>Ratri</i> 18 \times 25 ν .—Sun enters 3d <i>Padah</i> of <i>Nacshatra Revati</i> 9 \times 57 ν .— <i>Mercury</i> enters 2d <i>Padah</i> of <i>Revati</i> 0 \times 0 ν .

KALENDAR.				Chaitra, continued.	Ephemerides.
April.	Poongoni, or Chaitram.	Chaitra.	Feix.	Sacha Poesha.	
5	25	6	Monday	Venus enters 2d Padah of Purva Bhadra 5z— <i>Calpa dia</i> , anniversary of the beginning of <i>Calpa</i> . End of T. 25z 46v— P in Nacshatra Magsiras (5th) issues at 26z 7v—Yogù Sôbhana (6th) ends 47z 42v—Curna Dhitala (1th) ends 25z 46v—Thyajum of Wurjum, Ratri begins 15z 32v—Tidhi Shusti, on which there is <i>Srardum</i> , or ceremonies for the dead.	
6	26	7	Tuesday	End of Tidhi 20z 31v— P in Nacshatra A'rdrâ (6th) issues 25z 1v—Yogù Atiganda (6th) ends 40z 43v—Curna Warnajee (6th) ends 20z 51v—Thyajum of Wurjum, Ratri begins 20z 43v—Mercury enters 3d Padah of Nacshatra Revati 34z—Venus enters 3d Padah of Nacs. Purva Bhadrâpada at 38z—Ketu's (P 's 93) <i>Crantum</i> —Sun's <i>Vethel</i> —Tidhi Duttia—Santara Septami; ceremonies for the dead, (meaning that the ceremonies which ought to have been performed on the 2d Tidhi are postponed until this day.)	
7	27	8	Wednesday	End of Tidhi 10z 27v— P in Nacshatra Punarvasu (7th) issues 19z 25v—Yogù Sucarma (7th) ends 32z 21v—Curna Bhava (1st) ends 15z 27v—Thyajum of Wurjum, Ratri begins 7z 35v—Sun enters 4th Padah of Nacshatra Revati at 33z 38v—Navami Tidhi— <i>Srardum</i> ceremonies for the dead—Sri Ram's birth day.	
8	28	9	Thursday	End of Tidhi 6z 35v— P in Nacshatra Pushia 15z 27v—Yogù Dhriti (8th) 25z 40v—Curna Coulava (3d) 9z 33v—Thyajum of Wurjum, Ratri (night time) begins 14z 42v—Mercury enters 4th Padah of Nacshatra Revati 30z.	
9	29	10	Friday	End of Tidhi 3z 20v—Oppadi (expunged) Tidhi, ends 54z 0v, its name Yacadesi— P in Nacshatra Aslekhâ 11z 18v—Yogù Sôla (9th) 18z 1v—Curna Garujah (6th) 3z 20v—2d Curna (of the expunged day) Warnajee (6th) 27z 0v—Thyajum of Wurjum, Ratri (night time) 8z 31v—Mars <i>retrograde</i> , enters 2d Padah of Nacshatra Phalguni 8z—Venus enters 4th Padah of Nacs. Purva Bhadrâpada in the Solar Sign Min 3z 31z—On account of the Oppadi, or Avamaha Tidhi Yacadesi, the distinguishing marks of castes to be generally painted on the forehead.	Cshaya.
10	30	12	Saturday	End of Tidhi 51z 50v— P in Nacshatra Meghâ 7z 10v—Yogù Ganda (10th) 10z 22v—Curna Bhava (1st) 24z 40v—Thyajum of Wurjum, Dori (day time) 25z 24v—Sun enters 1st Padah of Nacshatra A'swini and the Sign of the fixed Zodiac Mesha at 57z 43v—Mercury enters 1st Padah of Nacshatra A'swini in the Sign Mesha at 6z—Saturn's Latta—This Tidhi Yacadesi, a fast for the followers of Vishnu.	

KALENDAR.

April.	Chaitram or Vaisācha.	Chaitra.	Ferīā.
11	1	13	Sunday
12	2	14	Monday
13	3	15	Tuesday
14	4	1	Wednesday
15	5	2	Thursday
16	6	3	Friday
17	7	4	Saturday

Christian Pascha.

Chaitra, continued.

Ephemerides.

Sucha Pascha ends. Christian Pascha (or dark half of the month) begins.

End of Tithi 48g 24v.— \mathfrak{P} in Nacshatra Purva Phalguni ends 3g 18v.—Do. in Uttara Phalguni ends 56g 41v.—Yogū Vrīkdhī (11th) ends 2g 57v.—Do. Dhṛatva (12th) ends 53g 0v.—Curnā Coulava (13th) ends 19g 5v.—Thyājum of Wurjum, Devī (day time) begins 20g 19v.—Mercury enters 2d Pada of Nacshatra Aświni 34g.—Jupiter enters 3d Pada of Nac. Aświni 16g.—Mars' Crantum.—Sun and Rahu's (\mathfrak{P} 's 55) Crantum (no marriage ceremony).—Vishuvat Pānīacata (certain ceremonies recurring about the Equinoxes to be performed).—Samarga (middle state of agricultural prosperity) time for sowing the fields.

End of Tithi 41g 43v.— \mathfrak{P} in Nacshatra Hasta ends 57g 22v.—Yogū Vyāghātā (13th) 49g 25v.—Curnā Garujee (5th) ends 14g 5v.—Thyājum of Wurjum, Devī (day time) begins 21g 2v.—Venus enters 1st Pada of Nacshatra Uttara Bhādrapada 15g.

End of Tithi 37g 34v.— \mathfrak{P} in Nacshatra Chitra ends 55g 16v.—Yogū Herahana (14th) ends 43g 27v.—Curnā Bhādra (7th) ends 9g 30v.—Thyājum of Wurjum, Devī (day time) begins 16g 31v.—Mercury enters 3d Pada of Nac. Aświni 44g.—Mars' Iatīa.—Accession of Rouchya Manu (the 15th of the 14 Rulers of the Calpa).—Chitra Purnima Tithi, (the Lunar day of opposition or full Moon) general observances.

End of Tithi 34g 23v.— \mathfrak{P} in Nacshatra Swātī, ends 54g 10v.—Yogū Vajra (15th) ends 38g 21v.—Curnā Bhālava (2d) ends 5g 55v.—Thyājum of Wurjum, Devī (day time) begins 8g 55v.—Sun enters 2d Pada of Nacshatra Aświni 21g 51v.—Venus enters 2d Pada of Uttara Bhādrapada 58g.—Saturn enters 3d Pada of Nacshatra Criticā 34g.—Beginning of the Triplicane feast. The Christian Pascha (obscure half of the month) begins.

End of Tithi 32g 25v.— \mathfrak{P} in Nacshatra Viśācha, ends 54g 34v.—Yogū Siddhi (16th) ends 34g 10v.—Curnā Dhīatā (4th) ends 3g 24v.—Thyājum of Wurjum, Devī (day time) begins 8g 23v.—Mercury enters 4th Pada of Nacshatra Aświni 34g.

End of Tithi 31g 44v.— \mathfrak{P} in Nacshatra Anurādhā, ends 56g 0v.—Yogū Vyatipātā (17th) ends 30g 56v.—Curnā Warnajee (6th) ends 2g 5v.—Thyājum of Wurjum, Devī (day time) begins 4g 48v.—Triplicane feast continues.—Procession of Gurulāsavam.

End of Tithi 32g 15v.— \mathfrak{P} in Nacshatra Jyēstha ends 58g 42v.—Yogū Vairīyā (18th) ends 28g 35v.—Curnā Bhava (1st) ends 2g 0v.—Thyājum

KALINDAR.			
April.	Chaitram or Vaishāṇa.	Chaitra.	Periz.
16	8	5	Sunday
17	9	6	Monday
18	10	7	Tuesday
19	11	8	Wednesday
20	12	9	Thursday
21	13	10	Friday
22	14	11	Saturday

Christian Pascha.

of Wurjum, Devi (day time) 10^h 33^m—Sun enters 3d Padah of Nacshatra
 Aswini 40^h 22^m—Mercury enters 1st Padah of Nacshatra Bharani 26^h—
 Venus enters 3d Padah of Nacshatra Uttara Bhadrupada 41^h.

End of Tidhi 34^h 40^m—) in Nacshatra Mula ends 60^h—Yogū Pari-
 gha (19th) ends 27^h 30^m—Carna Coukata (3d) 3^h 12^m—Thyajum of Wur-
 jum, Devi (day time) begins 20^h 0^m—2d Thyajum, Ratri (night time)
 begins 27^h 30^m—Matsya deva's day, (anniversary of Vishnu's incarnation as
 a Fish).

End of Tidhi 37^h 9^m—) in Nacshatra Mula ends 2^h 36^m—Yogū Siva
 (20th) ends 27^h 11^m—Carna Garujee (5th) 5^h 40^m—Complement of Thy-
 ajum (the Moon having left the Nacshatra Mula on the preceding day at
 60 gaddias complete) called Shesha, Devi (day time) 2^h 21^m—2d Thyajum,
 Devi (day time) begins at 28^h 33^m—Mercury enters 2d Padah of Nacshatra
 Bharani 19^h.

End of Tidhi 41^h 5^m—) in Purra A'shād'hā, issues at 7^h 33^m—Yogū
 Siddha (21st) ends 27^h 42^m—Carna Bhudra (7th) begins 9^h 7^m—Thyajum of
 Wurjum, Devi 29^h 28^m—Mercury visible in the West at 26^h—Venus enters
 4th Padah of Uttara Bhadrupada at 24^h—Rahu's (♄'s ♀) *Urantam* in
 Purra A'shād'hā—Ketu's *Vethi*—Rahot Sarara (feast of the great
 chariot) in Triplisane.

End of Tidhi 45^h 46^m—) in Nacshatra Uttara A'shād'hā, issues 13^h 21^m
 —Yogū Sādhyā (22d) ends at 28^h 47^m—Carna Bhalava (2d) ends 13^h 20^m
 —Thyajum of Wurjum, Devi begins 24^h 25^m—Sun enters 4th Padah of
 Nacshatra Aswini at 12^h 40^m—Sun enters the *Tropical Zodiacal Sign*
 Vrisha ♈ at 21^h 23^m—Mercury enters 3d Padah of Nacshatra Bharani
 at 12^h—*Ahu* (Dinarda, or duration of artificial day) 31^h 0^m.

Tidhi ends at 50^h 55^m—) in Nacshatra Sravana, issues 19^h 44^m—
 Yogū Sabha (23d) ends 30^h 12^m—Carna Dhitala (1th) 18^h 20^m—Thyajum
 of Wurjum, Ratri begins 30^h 50^m—Saturn's *Vethi*.

Tidhi ends 55^h 57^m—) in Nacshatra Dhanishṭhā, issues 26^h 18^m—
 Yogū Sutra (24th) ends 31^h 48^m—Carna Warnajee (6th) ends at 23^h 26^m
 —Thyajum of Wurjum, begins 15^h 40^m—Mercury enters 4th Padah of
 Nacshatra Bharani at 4^h—Venus enters 1st Padah of Nacshatra Revati
 at 7^h.

Tidhi ends at 60^h—) in Nacshatra Satubhisā issues 32^h 33^m—Yogū

KALENDAR.				Chaitra, continued.	Ephemerides.
April.	Chaitram or Vaisakha.	Chaitra	Feriz.	Christna Parsha.	
		Adigah Tidhi.			
25	15	11	Sunday.		Brahman (25th) ends at 5½g 7v.—Curna Bharva (1st) ends 28g 15v.—Thyajum of Wurjum, Ratri begins at 18g 57v.—Sun enters 1st Padah of Nacshatra Bharani, at 39g 22v.—Mercury enters 1st Padah of Nacshatra Critica at 57g.— <i>Tridina Sproohoo</i> (the meaning of which is that the Lunar Tidhi Chaturdasi is repeated.)
					Tidhi ends at 0g 34v.— P in Nacshatra Purva Bhadrapada, issues at 38g 3v.—Yogù Maha Indra, ends at 33g 48v.—Curna Bhalaria (2d) ends 0g 34v.—Thyajum of Wurjum, none.—Venus enters 2d Padah of Naca, Revati at 50g.—Ketu's (2's 8) <i>Latta</i> —a general fast—the men's foreheads to be painted according to their castes.
26	16	12	Monday.		Tidhi ends at 4g 16v.— P in Nacshatra Uttara Bhadrapada, issues at 42g 43v.—Yogù Vaidhriti (27th) ends at 33g 51v.—Curna Dhitala (4th) ends at 4g 16v.—Thyajum of Wurjum, Devi begins at 3g 53v.—Mars commences to be retrograde at 42g.—Mercury enters 2d Padah of Nacshatra Critica (in the Solar Sign Vrisha 8) at 56g.—Varaha Jyanti's birth day, (a celebrated Astronomer).
27	17	13	Tuesday.		End of Tidhi 7g 5v.— P in Nacshatra Revati issues 46g 14v.—Yogù Vishcambha (1st) ends 33g 56v.—Curna Warunjee (6th) ends 7g 5v.—Thyajum of Wurjum, Devi begins 14g 29v.—Mars' Vethel.
28	18	14	Wednesday.		End of Tidhi 8g 32v.— P in Nacshatra Aswini, issues at 48g 36v.—Yogù Priti (2d) ends at 31g 12v.—Curna Soyami, or Shakoni (8th extraordinary) ends at 8g 32v.—Thyajum of Wurjum, Ratri begins at 7g 4v.—Sun enters 2d Padah of Nacshatra Bharani at 6g 0v.—Venus enters 3d Padah of Nacshatra Revati at 33g.
29	19	Amavasya 30	Thursday		Amavasya, or conjunction, occurs at 8g 47v.— P in Nacshatra Bharani issues at 49g 41v.—Yogù Ayushmat (3d) ends at 28g 27v.—Curna Nagava (10th extraordinary) ends at 8g 47v.—Thyajum of Wurjum, Devi begins at 13g 2v.—Mercury enters 3d Padah of Nacshatra Critica at 2g.—Sun's <i>Grantum</i> .

End of the Lunar month Chaitra.

FRAGMENTS.

FRAGMENT I.

On the Formulæ of the Hindus for calculating the Eclipses, the Tables of Sines and divers other Astronomical Problems. Extracted from the French Ephemerides (Connoissance des Temps) for the year 1803, and ascribed to Mr. Delambre. (Page 447.)

THESE Formulæ will be found in the second volume of the Asiatic Researches. Altho' they may have been long since known in Europe, nevertheless as the original Memoirs first printed in Calcutta, and subsequently reprinted in London, are rather scarce, we deem it expedient to announce them to our readers, who, for the most part have never heard of their existence.

Ducham, Bailly, and Le Gentil, have published that the Indians have, for calculating the Eclipses, certain methods which they follow without understanding them.

The author of the Memoir referred to, Mr. Davis, combats victoriously that assertion, by giving in the minutest details, the computation of the Lunar Eclipse of the month of November 1789, which he worked by the Indian Formulæ; his demonstrations and illustrations being grounded on the precepts of the Sarriah Siddhanta.

The space which I have at command is too confined to enter into particulars; I shall therefore only state, that I have revised all these calculations with attention, and with the exception of a few points of the Indian doctrines, and of certain suppositions, the proofs of which are not very evident, one may aver that all the rest possesses all the perspicuity which the subject matter requires.

I cannot however, abstain from offering a few words on the Indian Table of Sines, and on the two methods according to which these are calculated; for since the publication of the Memoir, I have noticed in a note inserted at the foot of the Table, that I had not sufficiently appreciated the merits of the Indian method, because I have been led into a mistake by a constant number which seems to me not to have been exhibited in the Memoir with sufficient clearness.

In the Table under consideration the Sines are expressed in minutes; it proceeds $3^{\circ}1'$ to $3^{\circ}2'$ degrees, supposing the Radius to contain $3438'$; or rather $3437,75$.—On the same line with the Right Sines, the Table gives the Versed Sines.

If the process prescribed by the Indian author be examined carefully, one perceives easily that his method consists merely in calculating in the first instance a first difference which at the same time is the first Sine of the Table. After which, in order to obtain the second Sine, he calculates the second difference, which he subtracts from the first difference. This process gives the first difference between the first and second Sine; and consequently the second Sine; after which he

calculates another second difference to deduce therefrom a new first difference and a new Sine, and so forth to the end of the Table.

That process is precisely that which I indicated in the preface to the Decimal Tables of Borda, without knowing that this method, which seemed unknown even to the moderns, had been so long practised in India.

My Formula is $\Delta (2) \sin A = -4 \sin^2 \frac{1}{2} \Delta A \sin A = -\text{Chord } 2 \Delta A \sin A$. See Decimal Table, page 48.

Δ being the difference, A the Arc.

ΔA , being a constant quantity in the Table of Sines, it follows that in order to have the second difference of any Sine whatever, that Sine must be multiplied by a constant number. Now ΔA in the Indian Table is $3' 45''$, therefore $4 \sin^2 \frac{1}{2} \Delta A = 4 \sin^2 1' 52' 30'' = 0,0012321 = \frac{1}{811,117}$, from which it results that the constant factor for finding the second difference is $\frac{1}{811,117}$, that is to say, that the last Sine found must be divided by $\frac{1}{811,117}$. But according to the Memoir under consideration, that constant divisor, is $\frac{1}{812,5}$, which leads me to suspect that some typographical error has occurred, the more so that the numbers of the Indian author do not agree well with that divisor of 825, whereas with mine $\frac{1}{811,117}$, and following besides literally the precept, I find (with the exception of a few fractions) the same quantities; as may be seen in the following Table.

	Indian Sines.	Sines by the French Divisor.	1st Differences.	2d Differences.
0 0	000	000,00		
3 45	225	225,53	224,85	
7 30	449	448,73	223,89	0,06
11 15	671	670,71	221,97	1,92
15 0	890	889,81	219,10	2,87
18 45	1106	1105,10	215,29	3,81
22 30	1315*	1315,50	210,56	4,73
26 15	1520*	1520,59	204,93	5,62
30 0	1719	1719,01	198,42	6,51
33 45	1910	1910,07	191,06	7,36
37 30	2093	2092,95	182,88	8,18
41 15	2267	2266,85	173,92	8,96
45 0	2431	2431,08	164,21	9,71
48 45	2585	2584,88	153,80	10,41
52 30	2728	2727,61	142,73	11,07
56 15	2859	2858,66	131,05	11,68
60 0	2978*	2977,47	118,81	12,24
63 45	3084	3083,55	106,03	12,73
67 30	3177*	3175,30	92,85	13,20
71 15	3256	3255,54	79,25	13,61
75 0	3321	3320,95	65,31	14,04
78 45	3372	3372,04	51,09	14,32
82 30	3409	3408,19	36,63	14,41
86 15	3431	3430,74	22,03	14,60
90 0	3438	3438,10	7,36	14,72
93 45		3430,74	7,36	

This Table supposes a Radius greater than 3437,7, and less than 3438,4; according to Archimedes, the Radius would be between 3436,5, and 3438,5; mean 3437,4.

One may perceive that with the exception of some Sines, on which we only differ by a few tenths of a minute, the concordance is perfect in all the Table, whereas with the divisor 225, one would only obtain with approximate exactness the three first Sines, after which the error would increase with rapidity. I suspect that this erroneous divisor, is only a repetition of the divisor 225, which serves for finding the first of the first differences.

The Indian author does not state how he has found his divisor, therefore it can only be verified by the fact. Now the fact demonstrates that he has employed a divisor very little different from mine.

That process is extremely curious: one finds nothing like it in the Trigonometry of Ptolemy, and in order to find some vestige of it, one must, after having vainly poured over all the authors on Trigonometry, come to Briggs, who knew that divisor, which he seems to have found out by the fact, in comparing the second differences obtained by other means; for Briggs himself was not aware that it was the Square of the Chord of the differential Arc $\triangle A$.

But one may ask, why the Indians took $\triangle A = 3' 45''$, instead of $1'$. Here I believe follows the answer: it appears to me to have a considerable degree of probability.

There can be no doubt but that the Indians knew the following theorems, $\sin^2 A + \cos^2 A = \text{Radius}^2$; Versed Sine $A = \text{Rad.} - \cos A = 2 \sin^2 \frac{1}{2} A$: whence $\sin \frac{1}{2} A = (\frac{1}{2} \text{Rad.} - \frac{1}{2} \cos A)^{\frac{1}{2}}$. Now these three theorems are sufficient for finding all the Sines of their Table, and can give none else—they have therefore achieved all that they could, and their Table shows the limits of their science. Indeed one sees at page 250, that they have really employed these three Formulae for calculating that Table, and that they knew besides that the Sine of 30° is equal to half the Radius, which seems to leave no doubt on what I have said. Their Table thus constructed, they will have examined the first and second differences; and will have remarked that the first went on decreasing, but they will not have seen at first according to what law? The second differences on the contrary, went on increasing, and it was no difficult matter to discover that they were proportional to the Sines, for the second difference opposite to 30° is 7,36, and that opposite to 90° is 14,72, the double of the preceding one: and to find the ratio of the second difference to the Sine, they will have divided the Radius 3437,75 by 14,72, and found the quotient to be 233,53. Dividing thus every Sine by its second difference, they will constantly have found the same quotient, whence they will have concluded that in order to have the second difference, it suffices to divide the Sine by 233,53.

The Rule for the first differences is not so obvious, for the difference of $\sin A = 2 \sin \frac{1}{2} A \cdot \cos (A + \frac{1}{2} \triangle A)$, and the Sines $(A + \frac{1}{2} \triangle A)$ are not in the Table.

But the first of the first differences, is at the same time the first Sine in the Table; from which

they have concluded that with the first Sine, the first of the *first* and *second* differences, one had all that was necessary for calculating all the rest. But in truth the Table was already calculated when the Hindu computers gave their differential method, and the proof is, that to make their Table be such as they have given it, they had need to make the first Sine 224,53 and not 225, which would have given the first differences a little too great, and the Sines too small.

It is true that the *Surriah Siddhanta* directs to divide by 8 the number of minutes which is contained in one Sign, in order to have the first Sine, which comes to the same thing as taking the Sine to be equal to the Arc. Thus $\frac{90^\circ}{8} = \frac{360'}{8} = \frac{21600'}{8} = 2700' = 45^\circ$, whereas the true value found by the three theorems, is only 224',85. Observe that there is nothing conjectural in all this *but the reasoning*, which I suppose to be that of the Indian computer, for the Hindus had really all the knowledge which I ascribe to them. I do not pretend either that they used decimal fractions; it is with a view to shorten process that I employed these in reconstructing their Table of Sines, for it is well known that all their calculations are sexagesimal.

They might in taking proportional parts (the use of which was well known to them) extend their Tables to every degree of the circumference, but these interpolated degrees would have had Sines much less accurate, and they have preferred giving those which resulted immediately from their formulæ, and to preserve in all its purity the Table which was to serve for the computation of all the others; but they have given from degree to degree their Tables of Equation of the Center.

Their theory for calculating these Tables of Equations was incomplete and incorrect; although they used Epicycles as well as the Greeks for computing the inequalities of the Planets, that Calculus was with them less exact than that of Ptolemy: they had introduced an empirical Equation ill contrived enough, and they supposed that from 90° to 180° the same Equations returned in an inverse order. In that respect the Greeks were more advanced than the Hindus; their Trigonometry was more perfect, altho' that of the Hindus resembles ours most, and that the Hindus seem to have had some theorems unknown to the Greeks. These Tables of Equations, however defective, present nevertheless a curious consideration; which is, that in the explanation given of them by the Hindus, the differences of the Equations are proportional to the Sine of the Anomaly; or (what comes to the same nearly) that the variation of the Sine is proportional to the Cosine.

It will be found also in that Memoir, that the Hindus found the Latitude of a place by calculating the length of the Shadow of the Gnomon, particularly when the Sun was in the Equator: they might find it also by means, of the Solstitial Shadows on employing the greatest declination, which according to them was 24° .

For determining the Longitude they observed the Eclipses and compared them to the computations made on the Lunar Tables constructed for their first Meridian.

At page 315 one sees how, by means of their Sines, and without knowing the Tangents, they

computed the Sun's Right Ascension. Also how they computed the Ascensional differences and the point of the Equator which rose with each Sign of the Ecliptic. Their Table for the same was published by Le Gentil, who acknowledges not to understand upon what principles it is constructed; that principle is disclosed in the *Memoir* and I have commented upon it at full length in a Note.

We shall enter into no discussion on the antiquity of the Sarrish *Siddhanta* (*). If we were only to consider the form of their Tables, their ideas on the precession of the Equinoxes, their Obliquity of the Ecliptic of 24° , and the theory of the Eclipses, we might suppose the Hindu Astronomical books to be more ancient than those of the Alexandrian Astronomers. On the other hand, finding that they possessed knowledge which is not to be found among the Greeks, one would be tempted to suppose them more modern. All that is common between them is the system of Epicycles for the Planets, but less perfect than that of the Greeks, from which circumstance one might conjecture that the doctrine of the Indians has passed into Greece, where it was extended and improved. It would be less natural to suppose that the Hindus have received from the Greeks, through the channel of the Arabs, theories which are to be found in their hands but in a crude and incomplete state. All that we can affirm is, that the *Memoir* under consideration without teaching us any thing that might advance our real knowledge, or serve to the progress of Astronomy, is nevertheless singularly curious for all Astronomers. What renders the reading of it somewhat difficult, is the great number of Hindu technical words preserved in the translation. One might have given a second version where an European idiom alone would have been employed, and I had some thoughts of undertaking it, but to do this with success I had need of some further notions, and researches for which I had no sufficient time.

[*Connaissance des Temps, Année 1808, page 447.*]

(*) A learned Englishman formerly assigned 3840 years of antiquity to that book from the Epoch when he wrote. Since that time (in A. D. 1799) he has reduced that number of years to 724, i. e. to the year 1208 of our *Æra*.



FRAGMENT II.

On certain infinite Series collected in different parts of India, by various Gentlemen, from Native Astronomers.—Communicated by George Hyne, Esq. of the H. C.'s Medical Service.

I have stated in a Note at the foot of page 23 of the Key to the Siddhanta Chandra Manu, (article Hindu Gnomonics) that in Mr. Hyne's opinion the Hindus never invented the Series referring to the Quadrature of the Circle which were found in their possession in various parts of India; and that Mr. Whish, from whom he had obtained some of those which were communicated to the Madras Literary Society, after having first expressed a belief that they were indigenous, had subsequently reasons for thinking them entirely modern, and derived from the Europeans; observing that not one of the *Jyotish Sastras* who used these Rules, were capable of demonstrating them.

Since the time that I wrote the Note referred to, Mr. Hyne has done me the favour to communicate to me an account of the Series which had come to his knowledge; and I now lay the same before the reader in that Gentleman's own language, being well persuaded that it cannot fail to interest much all the votaries of science.

“MY DEAR SIR,

I have much pleasure in communicating the Series, to which I alluded in a former note to you, regarding the quadrature of the circle; and which some have supposed to have been invented by the Hindoos.

Let d be the diameter of a circle, and c its circumference; then the value of c may be obtained by any of the following formulæ.

$$(1) \ c = 4d - \frac{4d}{2} + \frac{4d}{3} - \frac{4d}{4} + \dots = 4d \left(1 - \frac{1}{2} + \frac{1}{3} - \frac{1}{4} + \dots \pm \frac{1}{2n-1} \right).$$

$$(2) \ c = 12\frac{1}{2}d \left(1 - \frac{1}{3 \cdot 2} + \frac{1}{5 \cdot 2^2} - \frac{1}{7 \cdot 2^3} + \dots \pm \frac{1}{(2n-1) \cdot 2^{n-1}} \right).$$

$$(3) \ c = 2d + \frac{4d}{2^2-1} - \frac{4d}{4^2-1} + \frac{4d}{6^2-1} - \dots = 4d \left(\frac{1}{1} + \frac{1}{1 \cdot 3} - \frac{1}{3 \cdot 5} + \dots - \frac{1}{2n-3 \cdot 2n-1} \right).$$

$$(4) \ c = \frac{8d}{2^2-1} + \frac{8d}{6^2-1} + \frac{8d}{10^2-1} - \dots = 4d \left(\frac{2}{1 \cdot 3} + \frac{2}{3 \cdot 7} + \frac{2}{5 \cdot 11} + \dots - \frac{2}{4n-3 \cdot 4n-1} \right).$$

$$(5) \ c = 4d - \frac{8d}{4^2-1} - \frac{8d}{8^2-1} - \frac{8d}{12^2-1} - \dots = 4d \left(1 - \frac{2}{3 \cdot 5} - \frac{2}{7 \cdot 9} - \dots - \frac{2}{4n-5 \cdot 4n-3} \right).$$

$$(6) \ c = 2d + \frac{4d}{2^2-3} - \frac{4d}{4^2-5} + \dots = 4d \left(\frac{1}{2} + \frac{1}{2 \cdot 3 \cdot 4} - \frac{1}{2 \cdot 5 \cdot 6} + \dots - \frac{1}{2n-3 \cdot 2n-1 \cdot 2n} \right).$$

$$(7) \ c = \frac{16d}{1^2+2^2} - \frac{16d}{2^2+3^2} + \frac{16d}{3^2+4^2} - \dots = 4d \left(\frac{4}{1 \cdot 5} - \frac{4}{5 \cdot 13} + \frac{4}{13 \cdot 21} - \dots \right) \\ = \frac{16d}{5} \left(\frac{1}{1} - \frac{1}{1+2^2+1^2} + \dots - \frac{1}{2+3^2+1^2+1^2+1^2} + \dots + \frac{1}{4n-1^2+1^2} \right).$$

All these series, are very easily derived from that, which expresses the arc of a circle in terms of the radius and the tangent.

Let x be an arc of a circle, of which t is the tangent; r being radius. Then, by the theory of functions, or, by the differential calculus, $x = r(t - \frac{t^3}{3} + \frac{t^5}{5} - \frac{t^7}{7} + \frac{t^9}{9} - \dots)$. If $r = 1$ and $x = 45^\circ$, then $t = 1$; and $c = 8x = 4d(1 - \frac{1}{3} + \frac{1}{5} - \frac{1}{7} + \frac{1}{9} - \dots)$, which is the first series. If $x = 30^\circ$, then $t = \frac{1}{\sqrt{3}}$, and $c = 12x = 6d(\frac{1}{3} - \frac{1}{3 \cdot 3} + \frac{1}{5 \cdot 3} - \dots) = 12d(1 - \frac{1}{3} + \frac{1}{5} - \frac{1}{7} + \frac{1}{9} - \dots)$, which is the second series. If the difference of each pair of terms of the first series be taken successively, then $c = 4d(1 - \frac{1}{3} + \frac{1}{5} - \frac{1}{7} + \frac{1}{9} - \frac{1}{11} + \dots) = 4d \times (\frac{2}{1 \cdot 3} + \frac{2}{3 \cdot 5} + \frac{2}{5 \cdot 7} + \dots)$, which is the fourth series; and, if we begin after the first term, then $c = 4d(1 - \frac{2}{3 \cdot 5} + \frac{2}{5 \cdot 7} - \frac{2}{7 \cdot 9} + \dots) = 4d(1 - \frac{2}{3 \cdot 5} + \frac{2}{5 \cdot 7} - \frac{2}{7 \cdot 9} + \dots)$, which is the fifth series. If the two last series, which are equal to each other, be added together, and each term of the sum be divided by two, then $c = \frac{4d}{2}(1 + \frac{2}{1 \cdot 3} - \frac{2}{3 \cdot 5} + \frac{2}{5 \cdot 7} - \frac{2}{7 \cdot 9} + \dots) = 4d \times (\frac{1}{2} + \frac{1}{1 \cdot 3} - \frac{1}{3 \cdot 5} + \frac{1}{5 \cdot 7} - \dots)$, which is the third series. If the terms of the following series $\frac{1}{2 \cdot 4} - \frac{1}{4 \cdot 6} + \frac{1}{6 \cdot 8} - \frac{1}{8 \cdot 10} + \dots$ be added and subtracted to and from those of the first, thus:

$$\begin{aligned} & 1 - \frac{1}{3} + \frac{1}{5} - \frac{1}{7} + \frac{1}{9} - \dots \\ & - \frac{1}{2 \cdot 4} + \frac{1}{4 \cdot 6} - \frac{1}{6 \cdot 8} + \frac{1}{8 \cdot 10} - \dots \\ & + \frac{1}{2 \cdot 4} - \frac{1}{4 \cdot 6} + \frac{1}{6 \cdot 8} - \frac{1}{8 \cdot 10} + \dots \\ \hline & 1 + \frac{1}{2 \cdot 4} - \frac{1}{4 \cdot 6} + \frac{1}{6 \cdot 8} - \frac{1}{8 \cdot 10} + \dots : \text{then} \end{aligned}$$

$$(6) c = 4d(1 + \frac{1}{2 \cdot 4} - \frac{1}{4 \cdot 6} + \frac{1}{6 \cdot 8} - \dots)$$

(7) If the terms of the series $\frac{1}{5}, \frac{2}{17}, \frac{3}{37}, \frac{4}{65}, \frac{5}{101}, \dots = \frac{n}{4n^2+1}$ be added and subtracted to and from different terms of the series $1 - \frac{1}{3} + \frac{1}{5} - \frac{1}{7} - \dots$ thus:

$$\begin{aligned} & 1 - \frac{1}{3} + \frac{1}{5} - \frac{1}{7} + \frac{1}{9} - \dots + \frac{1}{2n-1} \\ & - \frac{1}{5} + \frac{2}{17} - \frac{3}{37} + \frac{4}{65} - \frac{5}{101} + \dots \pm \frac{n}{4n^2+1} \\ & + \frac{1}{5} - \frac{2}{17} + \frac{3}{37} - \frac{4}{65} + \dots \pm \frac{n-1}{4(n-1)^2+1} \\ \hline & 1 - \frac{4}{89} + \frac{4}{2145} - \frac{4}{16935} + \frac{4}{91+4 \cdot 9} - \dots \pm \frac{4}{2n-1 \pm 4n-1} \end{aligned}$$

then $c = 4d(\frac{4}{1^2+4 \cdot 1} - \frac{4}{2^2+4 \cdot 2} + \frac{4}{3^2+4 \cdot 3} - \frac{4}{4^2+4 \cdot 4} + \frac{4}{5^2+4 \cdot 5} - \dots \pm \frac{4}{2n-1 \pm 4n-1})$, which is the seventh formula.

I am, my dear Sir, most sincerely, yours,

MAURAS, 17th August 1825.

G. HYNE."



FRAGMENT III.

On the Tantal Divisor of 576 years.—Text, page 8.

Independently of what has been said in the Text and Commentary of the Divisor 576, I shall remark one of its peculiarities which has hitherto escaped attention.

It is sometimes convenient in the course of investigation, and particularly in cases where the juxta position of Epochs is required, to set off on one side from a Root free from fractions. Now the period of 576 years enables us to resolve the Problem with great ease, provided an Epoch whose Root is an integer, be given.

For if out of Table I, we take the abstract Root for 576 years (*) we will find it to be (4)⁰ 0⁰ 0⁰, and as there are seven days in the week, on each of which the *Sanna Manna* may begin, if we multiply 576 by 7, we have 4032 years for product, whose abstract Root by Table I is (0⁰) 0⁰ 0⁰ 0⁰. (+)

EXAMPLE.

Let the initial Root of A. C. 3320 current, or 3320 complete, be resolved, it will be,

$$3320 - 3100 = \text{A. D. } 227.$$

Epoch A. D. 300, Table IX,

	D.	C.	T.	P.
200	(1)	0	50	15
20	(4)	10	25	0
7	(1)	48	38	45

Initial Root A. C. 3320 complete

227	(0)	0	0	0
-----	-----	---	---	---

Hence if to the Epoch A. C. 3320

(0)	0	0	0
-----	---	---	---

We add (or subtract) abstract Root for 576 years

+	(4)	0	0	0
---	-----	---	---	---

We have

Sum	(4)	0	0	0
-----	-----	---	---	---

Difference (3) 0 0 0

But if instead of the abstract Root for 576 years we use that of its multiple 4032 years, viz. (0⁰) 0⁰ 0⁰ 0⁰; it is manifest that the Epoch will remain as it was, relatively to the initial *feria*.

	D.	C.	T.	P.
(*) For the abstract Root for 576 years, Table I	309	(5)	20	25 0
	70	(4)	0	27 30
	6	(0)	32	1 30

Abstract Root 376 (4) 0 0 0

(†) For the abstract Root of the period of 4032 years we have, Table I,

1000	(5)	40	30	0
			×	4
4000	(1)	42	20	0
20	(2)	45	31	30
9	(3)	31	2	30

Abstract Root 4032 (0) 0 0 0

In the same manner, if there be any fraction in the proposed initial Root, or Epoch, the fraction in both cases will remain unaltered.

On this principle I have calculated the initial Roots of the following years, which exhibit every possible change which may occur where the generating Root or Epoch consists of integers only.

Generally, in the period of 4032 years the series of initial integer Roots in ascending progress will be 0, 3, 6, 2, 5, 1, 4, 0, &c. and in descending years 0, 4, 1, 5, 2, 6, 3, 0, &c.

This, however, is not to be mistaken for a Solar Cycle, excepting as far as the feria which begin the Solar years are concerned.

Years Saca complete	Years Callyugam complete	Years Ante Christum.	Roots of Initial Feria.
		3804	0
		3728	4
	449	2652	1
	1025	2076	5
	1605	1500	2
	2177	924	6
	2753	348	3
Anno Domini.			
150	3909	928	0
738	3905	840	4
1302	4481	1280	1
1878	5057	1955	5
2454	5633	2532	2
3030	6209	3108	6
3606	6785	3684	3
4182	7361	4260	0
4758	7937	4836	4
5334	8513	5412	1
5910	9089	5988	5



FRAGMENT IV.

Computation of an Eclipse of the Moon by means of certain memorial and artificial words, and of shells in lieu of figures; the formulae for which refer to the four Vakian Tables (the XXVIth, XXVIIth, XXVIIIth and XLVIIIth) published in this collection.—By Sami Naden Sashia, a Kalendar maker residing in Pondicherry.

I had often read and heard of the singular process by means of which the common Indian Almanac makers computed Eclipses; scoring their quantities with shells, instead of writing them in figures; and dispensing with the use of Tables, by means of certain artificial words, and syllables; which recalled the required numbers and Equations to their recollection, and was long desirous to obtain a positive proof of the truth of that report, which I always suspected to be much exaggerated. After a long search for one of these mechanical computers, a person was introduced to me by my venerable friend Abbe Mattet (one of the Missionaries of the Institution de Propaganda Fide in this part of India), and I found the Sashia thus introduced to me, competent to my object; for (as I wished) he did not understand a word of the theories of Hindu Astronomy, but was endowed with a retentive memory, which enabled him to arrange very distinctly his operations in his mind, and on the ground.

This person, whose name was *Samt Naden Sashia*, computed before me the Lunar Eclipse which forms the subject of the present Fragment; and after a due examination of his process, I concluded (as indeed I had expected) that the artificial words which were supposed to elicit results, were only designed as vehicles for finding the arguments of the four Vakian Tables published in this collection, and of some others not included therein, without which it would have been impossible for him to perform his task.

With regard to his calculating with shells and counters, (the latter representing zeros) it amounts to nothing more than scoring any number of points when playing at cards with similar articles, but on a larger scale. The multiplication and division of numbers, these computers abridge by means of particular Tables, generally constructed by themselves, which contain the number of multiples of the Elements which are likely to be wanted in the operation; so that in the first case, they find the product at once; and in the second, by help of the nearest quantity to the dividends they find the quotients in the adjoining columns, the operations being thus reduced to addition and subtraction.

The foregoing explanation may I believe, dispense me from representing all the figures resulting from the various dispositions of the shells in the different branches of the Problem, and admit of

my using figures in the more complicated part of this computation ; this being necessary to avoid confusion in explaining the process ; for there is no cancelling on paper, a rule which they cause to vanish by mixing the shells the instant that its results have been obtained ; preserving only the latter for future application in a distant part of the ground on which they operate.

Numerical account of the Sounds.

1 Ko ; Tho ; Poh ; Ya or Yom ; Klah ; wis ; Stah ; xulum.

2 Kha ; Thaha ; Paha ; Rra ; Kra ; Ra ; Ri.

3 Ghea ; Dhea ; Bhea ; la ; Kla.

4 Gaha ; Dhaha ; Baha ; Va ; Ve ; Koa.

5 Ghah ; Nah ; Ma or Mou ; Na ; Sa.

6 Tsha ; Ta ; Tou ; Shah ; Usha ; Cahu ; Reraha.

7 Tahah ; Tuha ; Saha ; Za.

8 Dja ; Dhen ; ha ; hi ; Dhea ; Do.

9 Djha ; Dhah ; Llah ; Iha.

O Gaia. Na. Ni. Rra, &c. (the last, or zero, being always expressed with a counter.)

A near approximation to all these sounds is considered as included in the list, and therefore renders their articulation very numerous.

This variety of sounds for the same number was invented for the purpose of avoiding cacophony, when using them to express large quantities, wherein the same figure may be repeated several times ; and also to give to the collected syllables the resemblance of a rational word.

When a regular *technical* term is too short to be split into as many syllables as the quantity which it expresses contains of digits, then they lengthen it at pleasure and construct by that means, a *memorial* word which answers their purposes. This will be exemplified in the following exposition of the Elements of the Yakkam process.

The Vedam, Va—do—da—Gaia—na—ton—Staha.

The Raza Gherica, Ra—za—Ghea—ri—ca.

The Kulacilam, Ka—la—ni—la.

The Deraram, Dhea—ra—ra.

These syllables they expand by inverting their arrangement, beginning with the last, and ending with the first ; and scoring from the right, thus :

Staha • —ton :::: — Na O — Gaia O — Dha :::: — Do :::: — Ve :: n

Vedam, or 1600984 days.

Ka • — Ri •• — Ghea ••• — Za •:::: — Ra •• a Raza Gherica or 13378 days.

La ••• — Ni O — la ••• — Ka • a Kulacila or 3031 days.

Ra •• — Ve :: — Dhea :::: a Deraram or 248 days.

As for the *Chandra Vakiam Dharmavana*, because it varies on each day of a *Devaram*, the computer retains that Element numerically in his mind; and the three digits which it contains (and can never exceed) recall to his recollection one of the 248 artificial words, which he learnt by heart; the sounds of each of which indicates the Moon's Equation due to the *Drava* of the day computed for. Thus, as will appear presently, the *Chandra Vakiam* on the 20th *Vyassei* (Bengal *Jyaishtā*) being 120, the computer says unto himself, Di—wia—ra—Ra—Dja, which inverting he finds in his memory,

Dja :::: — Ra ** — Va :: — wia * — Di :::: which indicates $8^{\circ} 21' 18''$.

If it had been for a *Vakiam* of 101, it would be, Dja—no—ma—unium—hi *, and by inversion hi :::: — unium * — ma ::* — no O.—Dja :::: which gives $8^{\circ} 15' 8''$, vide Table XXVI.

For the *Ahargana* and *Soola-dina*.

We need not repeat here what was so fully explained in the body of this work on the subject of these Elements. As the Almanac makers make their computations periodically, the *Ahargana* of the preceding year, furnishes them the means of finding that of the Sun for the beginning of the succeeding one, which is done by adding $365^{\circ} 15' 31' 16''$ thereto. And the absolute duration of each Solar month, such as given in Table III of this collection, (which they all know by heart) enables them to find that for any particular day in the year, without any formal computation.

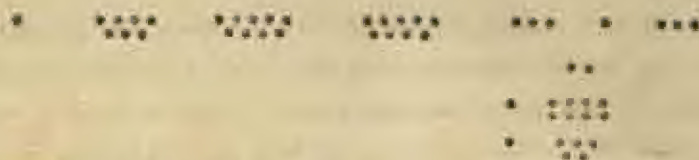
As for the recurrence of the new Moons, most of them use a Cycle of 19 years, like that of Meton; and with regard to the Eclipses (both Solar and Lunar) I believe many of them have learnt from the Europeans the use of the Chaldaic period of 223 Lunar months, or 13 years and 10 days; and that they venture to compute on a probability that they will hit on the proper day. I suppose that their knowledge of that period is of foreign origin; for I see it mentioned no where in their Astronomy. Certain it is however, that the common *Tamul* Kalendar makers, do not trouble themselves about the Lunar-solar *Ahargana*, and that in their computations of Eclipses, every thing rests on the Solar one. (*)

ARTICLE 1.

The computer having established that a Lunar Eclipse is likely to occur on the 20th day of the Solar month *Vyassei* (Bengal *Jyaishtā*) of the *Chakra* year *Parthiva*, being the 4926th of the *Cali* yug, and the 1747th since the birth of *Salivahana*, calculates his *Ahargana* as above described, and finds it to be $1799313^{\circ} 2' 18' 15''$, which he expresses thus, with his shells.

Vide Table III of this collection.

(*) Sam Nader acknowledged to me, that he had learnt how to determine when an Eclipse was possible, from Christian Missionaries; but that there was nothing about it in his books.



and dividing the sum of days by 7, he finds that the last expired day fell on *Tuesday*, and the current one on *Wednesday*; because altho' they count the remainder after division from *Friday* as zero, for the *beginning* of the years and months, they reckon *Friday* as 1, for the intermediate days of the month.

If we want to find the European date of these, *Tuesday* and *Wednesday*, we may have recourse to the methods which were disclosed in the first part of the *Key to the Siddhanta Saura samsa*: and *Tuesday* will be found to fall on the 31st of May (20th), and *Wednesday* on the 1st of June 1825, (21st Vyasa).

ARTICLE 2.

For the Sun's apparent place.

The next step to be taken is, to compute the Sun's apparent place at his rising on the *Soola dina*, which was explained at full length at page 124 and following, (*Key to the Siddhanta Chandra-mana*, Part II), and therefore need not be repeated here. I shall only give the abstract of the Rule, as follows:

1^o The *Ahargana* for the 20th Vyasa, (besides the sum of days) gave a fraction of

	23	13'	15"
which retrench from	60		
remainder	37	41	45

which *gaddias*, *vigaddias*, &c. are to be added as *calas*, *viculas*, &c. to the Sun's *Saura* degrees. (*).

To proceed.

For the Sun's Saura place.

2^o On the 20th Vyasa the Sun had moved through one complete Sign (that of *Mesha*)

Take for 19 complete days	-	-	1	0	0	0	0
" 57 <i>gaddias</i>	-	-	-	19	0	0	0
" 41 <i>vigaddias</i>	-	-	-	-	37	0	0
" 45 <i>prasa</i>	-	-	-	-	-	41	0
							45
Sun's <i>Saura</i> place at Sun-rise	-	-	-	1	19	57	41 45

3^o To equate which, we have by the *Yogbindi* Table (XXVII) for the first 3 days in Vyasa

Do. 2 ^o or 16 days	-	-	10	calas
And for 4 days that remain ($\frac{1}{4}$ of 22)	-	-	21	
			11	

Sum 51

(*) Vide Note at the foot of Table XXVII, part I. But then here we are to take 10', and not 20', for the 20th of Vyasa; otherwise we would have to subtract 8' 15".

But we want for $2^{\circ} 18' 15''$ less (page 337); therefore as we have 2° for 8 days, it is $\frac{1}{2} = 2^{\circ} 45'$ for 1 day, and $60^{\circ} : 2^{\circ} 45' :: 2^{\circ} 18' 15' : 6^{\circ} 20''$, which retrenching from $51'$ give the Equation sought $50^{\circ} 53' 40''$ subtractive. \odot 's Sura place $1^{\circ} 16' 57' 41' 45''$

Equation $-$ $-$ $-$ $50^{\circ} 53' 40''$

\odot 's *Sputa Graha* sought $1^{\circ} 19' 4' 48' 5''$

ARTICLE 3.

For the Moon's apparent place.

1^o We are first to compute the Moon's *Drava*; which is performed as indicated at page 132 and 133 of the second Memoir; it being remembered that the common Kalender makers perform their divisions and multiplications, by the help of Tables of multiples as stated at page 334 of this article; and the result in the present instance is 1 *vedam*; 16 *vaza gharikas*; 0 *calanilam*, and 1 *deraram*, with a remainder of 129, being the *Chandra Pakiam Dharmavanham*.—The four Elements they multiply into the respective Longitudes, as shown at page 133, the products being as follows:

1 vedam	-	-	-	7'	2'	0'	7"
16 vaza gharikas	-	-	-	2	23	20	40
No calanilam	-	-	-	0	0	0	0
1 deraram	-	-	-	0	27	44	0
Chandra Drava	-	-	-	10	24	34	53

which is to be equated by means of that operation which they call *Phala Trium Desentara*, (vide page 134, and Table XLVII.)

2^o It will have been found that after having divided the *Athargana* by the four Elements, there was a remainder of 129 days, which is the Argument of Table XXVI. Now these figures rec'd to the memory of the computer, the following artificial syllables.

Di—wa—va—ra—dja,—which being reversed and expounded

♦♦♦♦ Dja

♦♦ Ra ♦♦♦♦ Va

♦ Wa ♦♦♦♦ Di

produce $8^{\circ} 24' 18''$, which is the first part of the Equation required.

3^o For the Equation of the *Desentara calar*, we are to refer to Table XLVII, and find that those due to the preceding month, *Chaitram* (Bengal *Paisācha*) are $15'$, always additive. And for the *Andravicalas*, the same Table gives us for *Vyāsi*, itself — $10''$.

Now the odd degrees, minutes and seconds of the Sun's apparent place, being $19^{\circ} 6' 48''$ (present page) multiply the same by

$$\begin{array}{r} \times 10 \\ \hline \text{you have} \quad - 2^{\circ} 11' 8'' \end{array}$$

which, (as was explained at page 134), are to be subtracted from the *Desentara calar*, being the second Equation sought.

49 Lastly, for the *Madhya Gati vicalas*, we are to resort to the *Chandra Fabiam*, or Argument of Table XXVI) 129. Referring to the said Table we find the Moon's *Sputa Gati*, or true motion, for that number of days

But the Sun's mean motion is

Difference 35

and as for each *devaram* (248 days) elicited by the division of the *Ahargana* by the four Elements, there is an Equation of 32 *tarparias* or thirds, and as in the present case there was only one *devaram* in the results (page 337), we have $35 \times 32'' = 1120$ *tarparias* = $18^{\circ} 40'$; and on account of $40'$ say 19 *vicalas*, which is the third Equation required.

50 With these results we come to the following conclusion.

Moon's <i>Druva</i>	-	-	-	-	10° 21' 24' 53"
Chandra <i>Phala</i>	-	-	-	-	8 24 18 0
Moon's approximate Longitude	-	-	-	-	7 45 42 53
Decrements <i>calas</i> (page 338)	-	15'	0"		
Andra <i>vicalas</i> (page 338)	-	-	3 11		
Equation	-	11 49	-	-	+ 11 49
Madhya <i>Gati vicalas</i>	-	-	-	-	+ 19
Chandra <i>Sputa Graha</i> , 20th <i>Vyassol</i>	-	-	-	-	7 19 5 1

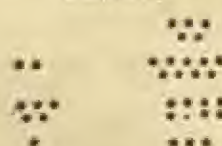
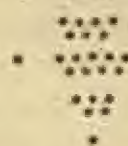
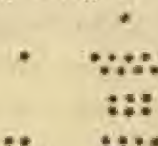
It is always to be understood that all these additions and subtractions are performed by the play of shells, which is very expeditious, but would have become tiresome if represented every time on paper.

ARTICLE 4.

For the Argument of the Purnima Tithi.

This article is for finding the instant of opposition, which is always the end of the 15th Tithi in the Lunar month. The operation consists in taking the difference of the Sun and Moon's Longitude, and then by the method indicated at page 137, to find the instant when it occurs *after that of true Sun rising*, on the particular day referred to, for which last article see also page 106.

These respective Elements the mechanical computer disposes, with his shells, in the following order.

Distance.	☽'s Longitude.	☉'s Longitude.
		
5a. 29° 58' 13"	7 19 5 1	15. 19° 6' 45"

and proceeding as above stated, he finds that the instant of opposition occurred on the 21st Vyssegi, at 0° 33' 00" after true Sun rising at the place computed for.

It is not however, to be believed that the common Almanac makers calculate the true duration of the artificial day and night in the manner that was explained in the second section of the 8th article of the Key to the Siddhanta-Chandramana, the problems of which are far beyond their comprehension. They have a Table where the time of the Sun rising and setting for every day in the year, is ready computed; which serves them for a great number of years, and to which they refer the end of each Tithi. When unable to construct it themselves, they procure one from their more learned colleagues.

ARTICLE 5.

For the apparent place of the Moon's Node, called Rahu.

Of the theory of this part of the Problem I could not obtain even the most general account; and circumstances of a painful nature, have prevented me from investigating it as I intended to have done. I give therefore the computation as I received it, with a belief however, that with the assistance of the data contained in this work, there will be no difficulty to demonstrate its several propositions.

1^o The Tamil Almanac makers use a constant number, recalled to their memory by the sounds Cke—the—na—Gua—Rao—Rashe—yam, which inverted as usual gives

Yam—Rashe—Rao—Gua—na—the—Cke

1 0 0 0 0 6 6

this number they subtract from the Ahargana (page 236) - - 1799813

(*) 1600086

Remainder 199727

2^o They next put down this remainder in two places,

	1 ^o		2 ^o
	199247	{ Multiply the 2d by 4 of the Periodical revolution of the Moon, or	199247
(vide infra)	- - * 10 33 36 30	- -	X 9
	199230 26 23 10		1793223

3^o This product is to be divided by another constant number recalled by,

Dhu—na—Dja—Dhu—ton—pum

which gives Pum—ton—Dhu—Dja—na—Dhu

1 6 9 8 0 9

(*) The daily motion of the Moon's Node being 2' 10" 43" 00" 50" 00" or 3' 10" 43", 1646 &c. If we suppose it to be in any point of the Ecliptic at the beginning of a period of 1600086 days, it will be precisely 0 Signs behind it, at the end of the same.

4. Proceeding to the said division, we have

$$\begin{array}{r} 169809 \overline{) 1703223} \text{ (10 days)} \\ 169809 \end{array}$$

$$\begin{array}{r} 93133 \\ \times 60 \end{array}$$

$$\begin{array}{r}) 8707980 \text{ (33 gaddias)} \\ 509427 \end{array}$$

$$\begin{array}{r} 813710 \\ 509427 \end{array}$$

$$\begin{array}{r} 104253 \\ \times 60 \end{array}$$

$$\begin{array}{r}) 6256580 \text{ (38 riguddias)} \\ 509427 \end{array}$$

$$\begin{array}{r} 1184710 \\ 104253 \end{array}$$

$$\begin{array}{r} 141856 \\ \times 60 \end{array}$$

$$\begin{array}{r}) 8634300 \text{ (50 paras)} \\ 8490450 \end{array}$$

$$\begin{array}{r} 140810 \\ \text{&c.} \end{array}$$

and this remainder they again divide by a number, recalled by the sounds, *Cake—tha—mum* ; which answers to

$$\begin{array}{r} \text{Mum—tha—Cake} \\ 5 \quad 6 \quad 6 \end{array}$$

In order not to confuse his shells, the computer performs that division in two or three steps, as to bring out round numbers, as much as he can ; thus

$$\begin{array}{r} 566 \overline{) 120236} \text{ (350 signs)} \\ 1698 \end{array}$$

$$\begin{array}{r} 2043 \\ 2830 \end{array}$$

$$\begin{array}{r} \text{Stop here} \quad - \quad 1136 \end{array}$$

Then arrange the shells thus
Multiply by 30

$$\begin{array}{r} 1136' 26'' 23' 10'' \\ \times 30 \end{array}$$

$$\begin{array}{r} 34098 \quad 11 \quad 25 \quad 0 \end{array}$$

Divide again the degrees by 566) 34093 (60 = 2 signs, which add to 250 above found.

$$\begin{array}{r} 3396 \end{array}$$

$$\begin{array}{r} \text{Stop here} \quad - \quad 133 \\ \times 60 \end{array}$$

$$\begin{array}{r} 7980 \end{array}$$

Add the minutes of the dividend -- 11

$$\begin{array}{r} 566 \overline{) 7991} \text{ (14')} \\ 566 \end{array}$$

$$\begin{array}{r} 2331 \end{array}$$

$$\begin{array}{r} 2264 \end{array}$$

$$\begin{array}{r} 67 \end{array}$$

$$\begin{array}{r} \times 60 \end{array}$$

$$\begin{array}{r} 4020 \end{array}$$

Add the seconds of the dividend - 35

$$\begin{array}{r} 566 \overline{) 4955} \text{ (7')} \\ 3962 \end{array}$$

$$\begin{array}{r} 93 \end{array}$$

which neglect.

Hence we have a quotient of $352^{\circ} 0' 14' 7''$ of which retroubling the complete revolutions, we have

From 12 signs	48 0' 14' 7''
Supplement	7 20 15 53
And add a Bijah of (*)	40 0
<i>Santa Rahu</i> , or true place of Ω ,	8 0 25 53

ARTICLE 6.

For the Patam Chandra Puram, or Argument of the Moon's Latitude.

1^o Retrench Rahu's place from the Moon's, increased by 12 signs.

Moon's Spata Graha, (page 339)	7 ^o 10' 5' 1 ^o
	12
	19 10 5 1
<i>Santa Rahu</i> Ω	8 0 25 53
	11 18 39 8
Take the Bhujah (page 80)	12
Argument of <i>Vishkpa calas</i> , or minutes of Latitude	0 11 20 32

2^o With 11^o refer to the *Vishkpa Patara cala* Table here annexed, you find

For 11	51 32
Proportional parts for $20' 52''$	1 37
<i>Nija Vishkpa calas</i>	53 9

which keep in reserve.

Table of *Vishkpa Patara cala*.

1	4	43
2	9	20
3	14	8
4	18	51
5	22	32
6	25	14
7	32	55
8	37	40
9	42	10
10	46	53
11	51	32
12	56	8
13	60	43
14	65	19
15	69	54

ARTICLE 7.

For the Chandra Mandala Libitangula.

The *Chandra Vakram Dharmavaaham*, which was found to be 129 days (page 338), when referred to Table XXVI, shewed that the Moon's true motion on the said *devaram day* was $246'$.

1^o Divide the same by

$25)246(33' 3''$

75

76

75

1

60

The quotient $33' 3''$ is called *Chandra Mandala Lihita*.

25)60(2

50

10

10 which neglect.

(*) The addition of these 60 rates in all computations of the place of the Moon's Node, by the Kalendar makers, appears to me manifestly sufficient.

Put down this quotient in two places,

	1 st		2 nd		3 rd		4 th
Multiply the 1st by	33' 2"	×	3	* Add	82	36	
Halve it	1	-	165 10	Halve it	113	27	
Carry it over		-	82 25 *	Mana Yogarda Libita	57	45 1/2	
				Subtract <i>Nija Vicshipa calar</i> (vide supra)	33	0	
				<i>Grahana Libita</i> , (Difference) which lay by	4	30 1/2	

(N. B.—Here we have two sides of a right angled triangle, viz. the *Mana Yogarda Libita*, 57' 45 1/2" or say 40" and the *Nija Vicshipa Calar* which keep in reserve.)

ARTICLE 8.

For the Csh'shna, or quantity of the Disk eclipsed.

Having found the difference of the above two Elements to be 4' 30 1/2"; or say 4' 40", we are to divide the same by the *Chandra Mandala Libita*, 33' 2" (1932") found at page 342, for which purpose we are to raise that quantity by repeated multiplications into 60, until the latter may divide the former.

$$4 \times 60 = 240' \text{ and } 240' \times 60 = 14400'$$

$$1932) 14400' (8,47 \text{ \&c.}$$

$$15836$$

$$6140 \text{ which neglect}$$

$$7918 \text{ \&c.}$$

and the quotient is the *Csh'shna*, shewing that 8.80ths of the Moon's Disk will be eclipsed.

ARTICLE 9.

For the middle, beginning and end of the Eclipse.

1^o Square the *Mana Yogarda Libita*, 57' 45" (Tamil process).

1 ^o	2 ^o	3 ^o	4 ^o
57	49	37	49
57	57	49	49
399	315	513	441
283	245	228	196
3249	2793	2793	2401

Divide the 4th product by 60) 2401 (40

Add the quotient to the 3d

Add the 3d

Divide by 60) 5636 (93,43

Add the quotient to the 1st

Mana Yogarda Varga

the square of 57' 45".

2^d Square the *Nija Vichhipa Cala* 33' 9".

1 ^o	2 ^o	3 ^o	4 ^o
33	9	33	9
33	33	9	9
<hr/>			
110	477	477	81
205			
2820			

Divide the 4th by 60) 81 (1
21 which neglect

Add the quotient to the 2d.

477
1

Add the second . 477

60) 955 (15' 55"

355
55

Add the quotient to the 1st . 2820"

13 55

Vichhipa Cala Varga (*) . 2821 55

3^d For the *Moola Varga*, or square of the third side of the triangle.

From the *Mama Vagnya Varga* . 3312' 46"
Subtract *Vichhipa Cala Varga* . 2821 55
Moola Varga . 517 51

4^d Find the square root of the *Moola Varga*, (Tamil process.)

	Single.	(*) 4 (†) 4 Double.	(*) 4 (†) 4 (*) 0 Single.	
Dispose the figures with shells thus $\overline{5} \overline{1} \overline{7} \overline{5} \overline{1}$	5	1	7	Of 117 that remain divide 100 by 40 (because 4 * is placed in the column of tenths).
Say $2 \times 2 = 4$	4			40)100 (2 \times 40 = 80
Place the product under 5, and over 1 (*) subtract the latter.	1	1	7	20
(x) Place the quotient 20 after division of 100 under 117, and subtract				Add 17
		3	0	Sum 37 (x)
		3	7	Say again $2 \times 2 = 4$ (*) 4
		3	7	which place at top in the column above 7, and under 7, below, from which sub- tract.
		3	3	

Multiply the remainder 33 by 60; and add to the product the 31 odd vicular, i. e. $33 \times 60 + 31$
= 2011", which divide by 44 expressed at the top of the Rule (* and †).

44)2011(45

1760

Rem. here . 251

(*) The 1st square by the Shampson rule is 2822' 46" 1", the 2d, 2821' 55" 21", and the square root of the 3d is 517' 46" 11", the difference proceeding from the Hindu rule neglecting the last fractions.

For the quotient 40 place 4 (*) in the column at top between (*) 4 and 1. Square the last quotient $40 \times 40 = 1600$, which divide by 40) 1600 (25' 40", and because the fraction 40 exceeds 40 (the half of the divisor 44) take 27.

$$\begin{array}{r} \text{From the preceding remainder} \quad - \quad 271 \\ \text{Subtract these 27} \quad - \quad - \quad 27 \\ \hline \text{Rem} \quad 244 \end{array}$$

$$\begin{array}{r} \text{Which divide again by } 44) 244 (5 \text{ 24} \\ \underline{220} \\ 24 \end{array}$$

and because the remainder exceeds 22, take 6 (*), which quotient place at top in the column between (1) 4 and 7.

Lastly, take the half of 44 (*) and 6) which amounts to 22, then the *Moola Varga Meta*, or the square root of the curvate distance, or *Manu Yagarda Libila* (page 343) is 22 calas, 46 vicalas, which lay by (vide note page 344.)

ARTICLE 10:

For the Graham Tinnor's Padhi, or half the duration of the Eclipse.

We have already seen (page 342) that the Moon's true motion for 129 days
of a *devaram* was $- - - - - 826$ calas.
And the Sun's true motion on the 20th Vyasa by Tamil account (*) is $- 67 \text{ } 15$
The relative motion is therefore $- - - - - 768 \text{ } 45$
or in vicalas $- 46125$

Now as we are to divide the *Moola Varga Meta* 22' 46", by the Sun and Moon's relative motion, raise it by repeated multiplication into 60, so that it may be divided by the latter, that is $22 \times 60 + 46 \times 60 = 81900$.

$$\begin{array}{r} \text{Then} \quad 46125) 81900 (1 \text{ guddlar} \\ \underline{46125} \\ 35775 \\ \underline{60} \\ 2130100 (46 \text{ viguddilas} \\ \underline{154500} \\ 305100 \\ \underline{276750} \\ 28350 \\ \underline{60} \\ 17010000 (36 \text{ paras} \\ \underline{138375} \\ 317450 \\ \underline{276750} \\ 40600 \text{ which neglect,} \end{array}$$

and the quotient is the Half Duration of the Eclipse, viz. $1^{\circ} 40' 35''$.

(*) The Sun's true motion on the 20th Vyasa, by Table XXVIII, is $37^{\circ} 14''$.

ARTICLE 11.

For assigning the time of middle, beginning and end of the Eclipse.

It was stated at page 340, that the Parvina Tidhi ended on the 21st of Vyassai at 0^h 30^m after true time of Sun rising. Now by the Tables which give the duration of the artificial days and nights for every day in the year, it appears that the duration of the day is 31^h 25^m 20th to 21st Vyassai. Of the night 23 23

23^h 23^m mark therefore the true instant after Sun setting when he rises again. But the Parvina Tidhi ended (the instant of opposition, page 340) at 0^h 30^m after ☉ rise. Let it therefore be added to

	23	23
End of Tidhi from preceding Sun set	23	23 after ☉ set,
End of Tidhi	23	55 0
From which retrench <i>Grahana Timoria Padhi</i> (page 345)	1	46 36
	22	9 24

Beginning of Eclipse on the 20th Vyassai after Sun set 27^h 8^m 24^s after Sun set the preceding evening,

	H.	V.	S.
To the time of beginning	27	8	24
Add 2 × 12 46 ^m 36 ^s	3	33	12
	30	41	36
But the Sun rose on the 21st at	28	25	0
	2	16	36

therefore the time of end of Eclipse on the 21st after Sun rise is, 28 16^m 36^s.

CONCLUSION.

Hence the Phases, or *Calaz*, of the Eclipse under consideration, are as follows:

Beginning 20th Vyassai	27 ^h 8 ^m 24 ^s	after Sun set,
Middle 21st do.	0 30 0	after Sun rise.
End do. do.	2 16 36	after do.
Digits eclipsed 2.60ths of the Moon's Disk.		

ARTICLE 12.

The Phases of the Eclipse as computed by the Tunnat Formula, compared to the same calculated for the Meridian at Madras according to the European method.

We have seen (present page) that the duration of the night from the 20th to the 21st Vyassai, answering to that of the 31st May and 1st June 1825,

	Indian time.	European time.
was	25 ^h 25 ^m	11 ^h 22 ^m
The half of which is	12 12½	5 41

which indicates that according to the Hindu account, the Sun rises on the 21st Vyasa at 5° 41' A. M. (*)

	C.	V.	P.	H.	'	"	"
To the time of Sun rising	14	12	30	5	41		
Add that wanting from the end of Purnima Tithi (page 340)		30	0		12		
Middle of Eclipse	14	42	30	5	53	0	0
Add and sub. $\frac{1}{2}$ duration (page 345) \mp		1	40		42	38	24
Beginning of do.	12	55	34	5	10	21	34
End of do.	16	29	6	6	35	33	24

which furnishes the following comparison,

	European.	Tamil.	Difference.
	H.	H.	
Beginning	5 15	5 10,35	4,25
Middle	5 30	5 53,00	23,00
End	5 44	6 35,23	51,23
Duration	12' 30"	8' 23"	4' 7"

Observation.

When it is considered how very coarse and undefined as to the place for which the Eclipse is computed, the process used by the Tamil mechanical computers unhesitatingly is, it is really surprising that these results should come so wide from the truth. It is not however, to be believed that they are always equally successful in their predictions, and that the people who are bound to religious observances when these phenomena recur, are never disappointed in their expectations. I recollect a circumstance which occurred not many years ago, when an Eclipse of the Moon had been announced for a certain evening in the Madras Panchangum; in consequence of which crowds of people had resorted to the Beach for performing their ablutions; but no Eclipse appeared; a circumstance which in China might have endangered the mistaken Astronomer's life, but with the gentle Indian, only occasioned a good deal of noise; and with a few, some merriment on his ill proficiency. The case I refer to may have proceeded from the ignorance of the *Sastra*; but it is certain (and will be readily believed) that even where the most skillful Astronomer is employed, no reliance can be placed on those raw predictions which are never certain within several hours of the time when an Eclipse is to occur.

It was originally my intention to have added an example of a Solar Eclipse to the foregoing one; but family afflictions, and want of health, have prevented me from farther gratifying the reader's curiosity with disclosures of Indian mysteries.

(*) The Sun rises at Madras on the 1st June at 2h. 29', the difference of the two accounts is therefore 27,

I shall therefore, take a final leave of the *Kala Sanhita*, and trust it to its fate with all its imperfections ; taking this last opportunity for expressing my gratitude to the Supreme Government of India, to those of Madras, Bombay, and Prince of Wales' Island, for having, whilst the edition of this work was in progress, manifested by public acts, their approbation of the author's *intentions*, and *perseverance*, in a pursuit in which he only engaged from a sincere and unaffected desire of paying a tribute of respect, (which he thought might prove acceptable) to a Government in whose service he has spent the most active part of his life.

THE END.

A
GLOSSARY AND INDEX
OF THE TERMS
OF
HINDU ASTRONOMY
USED IN THE
KALA SANKALITA.

Written in the year 1825.

• When looking in the Glossary for the explanation of a term used in the Text, or in any other book of Hindu Astronomy, it may so happen that the orthography has been altered in such a manner in the former that it is not to be found exactly where it otherwise should be. In such a case the reader will remember that according to Sir William Jones' system, the letter C is generally sounded hard: but should this consideration prove insufficient, he must then look for a word, the sound of which comes nearest to that of the term which he is seeking.

A GLOSSARY AND INDEX

Of the terms of Hindu Astronomy used in the Kala Sankalita, and in some other books treating of Hindu Astronomy.

THE accompanying Glossary is the indirect, though necessary result of the investigation which constitutes the subject of this work. As it was not compiled by design, and as the terms which appear in its columns were gathered from various books, consulted only with reference to the task which the Author had undertaken, this Appendix can boast of no real importance as a *Collection*. But if it be considered as a Key to the Text, and as an exposition of the variations in its orthography which were occasioned by the introduction of Sir William Jones' system (now generally followed in Madras), it may prove of great assistance to the reader, not only for perusing these Memoirs, but any other book of Hindu Astronomy.

If it be considered that six and thirty years have hardly elapsed since we possessed any sound knowledge of the principles of that science;—that during the said space of time, it was only cultivated by five or six Gentlemen, most of whom were ignorant of the *Sanskrit* language, and who were widely dispersed over the immense territory subject to the British power in India, in every part of which a variety of Idioms are spoken, no one will wonder to find so much dissimilarity in the manner of spelling terms which apply to none of the civil concerns of life, and several of which, many of the Natives of India never heard pronounced in the course of their lives. Nor can it be a matter of surprise if in many instances there remains still doubts in the minds of the learned of all countries, on the legitimate signification of certain technical terms, expounded by us, in this distant part of the world, when they see in Bengal the learned Colonel Dow write *Obatar Bah* (the name of the fourth Vêda) what the Pundits of Madras spell *Atharu vêda*. (*)

The Author has incautiously ventured to affirm in a note introduced at the foot of page 70 of the Text, that he has followed the orthography of Sir William Jones, Mr. Davis, and Mr. Scott; but he was not then sufficiently aware that these Gentlemen are far from having followed the same system; nay, that each of them did not in all cases write the same word alike. There is certainly a very sensible difference between the sounds elicited by the orthography of the term of *Arca Baghabala* and *Arcabahu phala*; and yet both bear the same signification according to the above authorities.

As for those terms which the Author learnt immediately from his native instructors, and which form a considerable part of this collection, he feels bound to declare that he is totally ignorant of the *Sanskrit* language, and that those technical words which he was the first to expound, were

(*) Vide Dow's *Hinduism*, vol. I, dissertation page xxix.

conveyed to his ear, by interpreters either *Telugu* or *Tamil*, whose pronunciation of foreign idioms is known to be very defective. The exact meaning of a word so presented to him, he could not expound according to the common process of *etymology*; he could therefore only discover it, either from the nature of the operation in the course of which it was employed, or by its affinity to other words in some of the living oriental languages: but it was not until the whole of this work was actually printed, that he succeeded in procuring competent judges, and obtained adequate means for correcting his orthography. He trusts therefore, that the frequent variations, and seeming inconsistencies which will be noticed in the Text and Glossary, will not be ascribed to neglect.

With respect to the principal article, namely, the signification of the terms, the Author declares that he has not introduced a single exposition, which did not come right home to his comprehension, either as to sense or application; and that he has borrowed none but from authentic and approved authorities.

In some few cases the Author and the *Pundits* whom he consulted, could not come to an understanding either as to the existence, or signification of a particular term; generally he relinquished the dubious expression when it was of little importance: but when he had cause to be satisfied that his sense of it was well established, he thought it his duty to persist, and insert it in his catalogue; but then the contested term is indicated by an asterisk.

In the arrangement of the articles it was found sometimes indispensable to follow the objectionable orthography in the leading column, because a different course would have perplexed too much the references; particularly in the use of the letter C, which (according to the system of Sir William Jones) supersedes in all cases the, sometimes, more appropriate K. For who would look for an explanation of the term *Kendra* in the right column, if (notwithstanding all warnings) it were announced to the eye by the word *Cendra*?—But the true spelling has always been observed in the Gloss, although it be not at all unlikely that the *wrong* orthography, more readily than the *right* one, would recal the term under consideration, to the recollection of a *Telugu*, or *Tamil* Sastri.



A GLOSSARY AND INDEX, &c.

(N. B.—The Arabic figures refer to the pages of the Text, and the Roman to those of the Preface and Chronological Tables, being distinguished by Pr. and Chr. Table prefixed to each.—The Letter C is to be pronounced hard in all cases.)

A

- ABHJIT**, (అభిజిత్) —The extraordinary *Nacshatra*, or Lunar mansion. When Astronomers, or Astrologers, have occasion for this, they insert it between the 21st and 22d *Nacshatras*, in which case they take 3° 20' from *Uttara Ashadha*, and 1° 40' from *S'raavan'a*; thus making it consist of 5°. It is chiefly used for Astrological purposes. Vide p. 309.—*Abhijit*, as a *Yoga* (or leading Star of a Lunar mansion) is the same as a *Lyræ*. Vide p. 73, 74.
- A'GAS'A**, (అగస్త) —A name for the Sky, or Firmament.
- ACSHA**, (అక్ష) —Terrestrial Latitude.—*Asha-ansa*, and *Asha Bhagas*. Degrees of.—*Asha Garna*; Hypotenuse; but in its Astronomical sense, means what Europeans call the *Argument of the Latitude*, as well as *Patana Cendra*. Vide from p. 94 to 96, and Tab. XXXIII, p. 44 of the Tables.
- ADIGAH**, (అధిగ) —(so wrongly spelt in the Text, but properly) *Athi*, or *Athica*.—When this word is prefixed to the name or numeral of a Luni-solar year, it implies that it is *embolimic*, or of 13 Lunar months. Thus *Athica Samvatsara* means an intercalated year. Vide p. 71.—When to the name of a month, it indicates an intercalary one. Hence *Athica masa* means an intercalated month. Vide p. 71, 72.—And lastly, to the name of a Lunar day or *Tithi*, that it is repeated on two consecutive days in the Calendar. Vide p. 72; also p. 63, 67, 68, 142; and Table XXIX.
- A'DITYA**, (అదిత్య) —An epithet given to the Sun; meaning the *Attractor*.—Such a designation given by the Indians to that great luminary, may give rise to conjectures and speculations in the mind of the natural Philosopher.
- AGASTYA**, (అగస్త్య) —The Star *Canopus*.
- AGNI SAVARNI**, (అగ్ని సావర్ని) —One of the 14 Patriarchs who preside successively over the 14 *Manvantaras* of the *Calpa*. Vide p. 311.
- AGRA**, (అగ్ర) —Amplitude. *Agra Bhagas*; degrees of. Vide p. 91, 101.—*Agrajya*, sine of the Amplitude. Vide p. 102.
- AGRAHA-YANI**, (అగ్రహయనీ) —(written *Agrahayan* in the Text)—A new name given to the Solar month *Margasirsa*, when the latter was made to commence the year.—This event is supposed by some

to have occurred 698 years before Christ; when, according to the same authorities, the *Ayanansa* was accounted to be 6° 40'. Vide p. 5, 215, and article *Ayanansa*.

AHARGANA, (అహరగణ) — The number of days from a given Epoch, to the time for which a computation is made. Vide Pt. p. vii; Text, 8, 9, 53, 171, 239, 241, 336, and Table XLI. — N. B. The term *Ahargana*, is not used to express the number of days expired since the epoch of the creation. (See *Sinastidi Digama*).

AHAS, (అహస్) — The length of the artificial day. Vide p. 313, 318.

ALIPALA, (అలిపాల) — The 1,600th part of a *Canta'calā*. Vide p. 6.

AMA'VA'SYA, (అమావాస్య) — The conjunction of the Sun and Moon, also called *Arcānda-Sangama* (written in the Text *Arca'anda*) — *Amā*, and *Darśa Tithi*, are other names given to the Lunar Day, on which the conjunction occurs; which is the Kalendula is always reckoned the 30th of the Lunar month. Vide p. 68, 70, 137. — *Amāvāsiya Tithi*, the lunar day of the Moon's change. Vide p. 78, 108.

AMRĪTA, (అమృత) — The water of immortality, obtained by the churning of the ocean, and the occasion of the war between the *Suras*, and *Asuras*, in which the gods took a part. This indicates the occurrence of the first Solar Eclipse on Indian record. Modern European commentators conjecture that it fell on the 25th October in the year 943 before Christ.

ANALA, (అనల) — The name of the 50th year of *Jupiter's* cycle of 60 years. Vide I Chr. Table.

A'NANDA, (అనంధ) — The name of the 48th year of the same cycle. Vide do.

ANANTA, (అనంత) — *Infinity*; *Eternity*; *Time*; — also, the King of the Serpents.

ANANTA SAYANA, (అనంతశయన) — *Persevere*. Vide Table XXXIII, p. 41 of the Tables.

ANGA'RACA, (అంగారక) — One of the names of the Planet *Mars*.

A'NGIRA, (అంగిర) — The 6th year of the cycle of 60 years. Vide I Chr. Table.

ANGULA, (అంగుళ) — A digit, or 1-12th part of any dimension; subdivided into 60 *vyangulas*. Vide p. 102, 111. — *Little angula*, digits obscured in an Eclipse. Vide p. 312.

ANSA, (అంశ) — Degrees (Vide *Bhuga*). Also the numerator of a fraction.

ANURA'DHA, (అనూరాధ) — The 17th Lunar mansion. Vide p. 71.

ANTARA, (అంతర) — (written *Andra* in the Text) — An intermediate space, a difference in computations. — *Antara viculas*, surplus seconds. Vide p. 131 and Table XLVII, p. 63 of the Tables.

ANTERA, (అంతర) — Last. — *Prathamā*, *Madhya*, *Antya*. First, mean, last. Vide p. 103 referring to the *Chāra cunda*.

A'RABHA, (అరభ) — Beginning.

ARCA, (అర్క) — One of the names of the Sun.

ARCABAHUPHALA-SANSCARA, (అర్కాబాహుఫలశంసకర) — In some Mss. *Arcabhagabala* (and

written in the Text, *Arca haboota* and *Arca bhahala*)—The arc which a Planet describes during that part of the equation of time, which arises from the inequality of the Sun's motion in his orbit: being an equation to which all the Planets are subject, but the motion of which it differently affects. Vide p. 87, 88, 184, 185, 190; and Table XXVII, part 2, p. 33 of the Tables.

ARC'ENDU SANGAMA, (అర్కేందుసంగమం) —The instant of true conjunction of the Sun and Moon. Vide p. 70.

AR'DHA, (అర్ధం) —The half.—*Dina ardhā*; half the day; *Ratni ardhā*; half the night. Vide p. 106.

AR'DRA, (ఆర్ద్రం) —The 6th Lunar mansion. Vide p. 74.

ARPEŚI, (అర్పిశి) —The 7th month of the Solar year, Tamil denomination, answering to the Hindu month *Cartiga* during which the Sun is in the Sign *Tula* ♎. Vide p. 5, and Table III, p. 3 of the Tables.

AR'YA BHATTA, (అర్యభట్ట) —A celebrated Hindu Astronomer who flourished in the 422d year of the *Cali yug*, answering to A. D. 1322. He left several Mathematical tracts, some particularly relating to the properties of the Circle.

AR'YA-SIDDHANTA, (అర్యసिद्धन्ता) —A treatise of Astronomy, composed by *Arya bhatta*, of which there is a spurious one. There is some variation in the copies of this work preserved in Bengal and in the Carnatic, the former making the Solar year 3656 154 31p 17c 6", the latter 3654 152 31p 15p; and the Lunar Synodical month, the former 29d 31c 20p 6p 7s 84, &c. and the latter 29d 31c 50p 5p 40s 21, &c.—N. B. The copy used in this work is that of the Carnatic. Vide p. 7, 66, 118, 199, 205, 239, and Tables XLVIII and XLIX, p. 63 and 64 of the Tables.

ARUNA, (అరుణ) —The dawn, or *Aurora*, mythologically the *Character* of the Sun.

A'SHA'D'HA, (అషాఢ) —*Purva* the 20th, and *Uttara* the 21st Lunar mansions. Vide p. 74.—The 4th Lunar month. Vide p. 69.

A'SHA'D'HA, (అషాఢ) —The 3d Solar month, Hindu denomination, when the Sun is in the Sign *Mid'huna* II, answering to the Tamil month *Audi*. Vide p. 5, and Table III, p. 3 of the Tables.

AS'LE'SHA, (ఆశ్లేష) —The 11th Lunar mansion. Vide p. 74.

ASTA, or ASHTA, (అష్ట) —Eight.—*Asta' dic.* The 8 points of the compass, including the cardinal ones.—N. B. This word is wrongly interpreted at page 22, where the *Asta Dikas* are stated to be the 4 intermediate divisions of the compass.

ASTAMI, or ASHTAMI, (అష్టమి) —The 8th Lunar day of the *Paccha* or demi-lunar month. Vide p. 70.

AS'URA' DHRUVA, (అసురధ్రువ) —The South-Pole.

ASURAS, (అసుర) —Its inhabitants, opposed to the *Sāras*, those of the North Pole.

AS'WINA, (ఆశ్విన) —The 6th Solar Hindu month, when the Sun is in the Sign *Canya* ♎, answering to the Tamil month *Paravasi*. Vide p. 5, and Table III, p. 3 of the Tables.

- AS'WINI, (అశ్విన) —The first Lunar mansion. Vide p. 74.
- ATHARAVANA' or ATHARA VEDA, (అథర్వవేద) —The fourth of the inspired *Vedas*. This book comprehends the whole science of Theology, Metaphysics and Philosophy.
- ATCHU, (అచ్చు) —A term used by Father Beschi after the Southern Astronomers, to signify an Epoch.
- ATIGAND'A, (అతిగంధ) —The Vega Star of the 6th Lunar mansion, perhaps the 133d of *Taurus*, but very uncertain. Vide p. 74.
- AVANTI, (అవంతి) —Supposed to be the ancient name of *Ujan* or *Oogrin*. Vide p. 9.
- AVATA'RA, (అవతార) —Descents of the Deity in various shapes, and under various names, of which *Rama*, and *Crishna* are the most remarkable. Vide p. 311.
- AUDI, (అది) —The 4th Solar month, Tamil denomination, answering to the Hindu *Śrāvaṇa*, when the Sun is in the Sign *Cancer* ♋. Vide p. 3, and Table III, p. 3 of the Tables.
- A'UNI, (అుని) —The 3d Solar month, Tamil denomination, answering to the Hindu *Āshāṛa*, when the Sun is in the Sign *Mid'hana* II. Vide p. 3, and Table III.
- AYA'MA'HA, (అయమాహ) —A term used in the Calendar for expressing an expunged *Tithi*, or Lunar day. Vide p. 72, 312.
- AYANI, (అయన) —The 5th Solar month, Tamil denomination, answering to the Hindu *Bhādra*, when the Sun is in the Sign *Sinha* ♌. Vide p. 3, and Table III.
- AYANA', (అయన) —A name applied to the Equinoctial, and Solstitial points.—*Mēsha Ayana*; *Tula Ayana*; the Vernal and Autumnal Equinoxes.—*Uttara*, and *Dakṣiṇa Ayana*; the Northern and Southern Solstices.—*Ayana Bhāga*, (vide *Ayana's'a*)—*Ayana Cāla*; the time from an Equinox to the ensuing one. Vide p. 4, 70, 77, 308.
- AYANA'NS'A, (అయనాంశ) —The arc between the Vernal Equinoctial point, and the beginning of the Solar Syderal (or fixed) Zodiac (or the first point in the Solar Sign *Mēsha* ♈), being one of the most important elements of Hindu Astronomy, as it refers the Syderal, to the Tropical Zodiac. (Vide *Crānti-Pata.Gat.Rishis*). Vide also Pr. p. x, Text p. 19, 76, 84, 183, 246, 247, and Tables XXXV and XXXVI, p. 46 and 47 of the Tables.
- AYUSHMAT, (అయశ్మత్) —The Vega Star of the 3d Lunar mansion, *Alegone*. Vide p. 74.

B

- BAD'ABA'NALA, (బాదాబానాల) —A name sometimes applied to the South Pole.
- BAH'DANYA, (బాహుదాన్య) —The 12th year of Jupiter's cycle. Vide Chr. Table I.
- BA'LABITYACALU, (బాలాబిత్త్యళలు) —(spelt in the Text *Balla datty callo*)—A Telugu Astronomer who wrote in the 4538th year of the Call yug. Vide p. 9.

- BALARAMA**, (बलरामः)—The 8th Incarnation of *Vishnu* as a *Chakrtya*, the anniversary of which is noticed in the *Kalendar*. Vide p. 311.
- BALAVA**, (बालः)—The second *Carana*. Vide p. 73.
- BAVA**, (बवः)—The first *Carana*. Vide p. 73.—Also the name of the 8th year of the cycle of Jupiter. Vide 1 Chr. Table.
- BHAGAN**, (भगः)—An arc equal to the 1-360th part of the circumference of a Circle; or one degree. Vide p. 77.—*Bhaga*, *Anubanda*, or *Aparicha*; an infinite series. Vide p. 93.
- BHAGAN'A**, (भगः नक्षत्रं)—The circumference of a Circle.—Independently of Astronomical purposes, the Indians frequently divide the circumference of the Circle into 12 *Ras's* or Signs, subdivided sexagesimally into *Bhagas*, *Calas*, *Viculus*, &c. i. e. degrees, minutes, seconds, &c.; vide p. 85.—*Bhagan'a* means also a revolution.
- BHA DRAPADA**, (भद्रपदः)—*Purva* the 23th, and *Uttara* the 20th Lunar mansions; vide page 74.—The same word, or merely *Bhādra*, is the name of the 5th Solar-Hindu month, answering to the Tamil *Auvani*, when the Sun is in the Sign *Sinhā* ♋. Vide p. 5 and Table III, also p. 232.
- BHAGAVATA**, (भगवत्)—An historical book, reckoned authentic.
- BHANU**, (भानुः)—A name or epithet of the Sun.—*Bhanu Harputta Chandra nama*, or properly *Barharputta manu*. Vide *Manu*, also p. 148.
- BHABANTI**, (भभ्रं)—The second Lunar mansion. Vide p. 74.
- BHASVARA, A'CHARYA**, (भस्वरः अचार्यः)—An Indian Astronomer who wrote a commentary on the *Arya Siddhanta*. He is stated in Hindu books, to have flourished in the 3232d year of the *Caligya* (A. D. 1150); but it is known that he was posterior to *Arya bhattacha* who wrote his treatise in A. D. 1322.
- BHACHYA**, (भक्षः)—One of the 14 Patriarchs who are supposed to preside successively over the 14 *Manvantaras* of the *Calpa*. Vide p. 311.
- BHAUMA**, (भौमः)—One of the names of the Planet *Mars*.
- BHRIGU**, (भृगुः)—A name of the Planet *Venus*.
- BHU**, (भूः)—Seems to imply the middle place.—*Bhū chakra*, when applied to the Celestial Sphere, means the Equinoctial line.—*Bhū caru*, the Radius of the Equator.—*Bhū paridhi*, the same as *Bhū chakra*.
- BHUBRA**, or **VUSTI**, (भुवः)—The 7th ordinary *Carana*. Vide p. 73.
- BHULA**, (भूलः)—Is an astronomical argument, peculiar to Hindu astronomy; it is to be considered as follows: 1^o If the arc exceeds 3 Signs—subtract from 6 Signs. 2^o If it exceeds 6 Signs—subtract 6 Signs therefrom. 3^o If it exceeds 9 Signs—subtract from 12 Signs; vide p. 63, 85, 114.—*Bhujajya*; the sine of the *Bhaja*.
- BHUMI**, (भूमिः)—The Terrestrial Globe, supposed to be in the center of the universe.—*Bhumi vikasya*

proper, natural to the Earth.—*Bhūmi sāvana dina*; a natural day. Vide p. 5, 78, 79, 101, 103, 225.

BTJA, (बीज) (sometimes written *Itjah* in the Text).—An equation or correction. Vide p. 36, 81, 100.

BORNA COTI, (बोर्नाकोटी) (बोर्नाकोटी).—The third imaginary city, supposed to lie under the Equator at 90° from *Lanka*. Vide p. 9.

BRAHMA, (ब्रह्मा) (ब्रह्मा).—The first person of the Hindu triad, and the Creator of the world: no direct worship is addressed to *Brahma*; and no temples are dedicated to him.

BRAHMA A'CHA'RYA BRAHMA GUPTA, (ब्रह्मचर्य) (ब्रह्मचर्य).—Supposed by some to be one and the same Astronomer, and the Inventor of the system disclosed in the *Sūrya Siddhānta*—by others to be two distinct commentators of that *Sūtra*.

BRAHMA SA'VARNI, (ब्रह्मसवर्णि) (ब्रह्मसवर्णि).—One of the 14 Patriarchs who are supposed to preside successively over the 14 *Manvantaras* of the *Calpa*. Vide p. 311.

BRAHMA SIDDHA'NTA, (ब्रह्मसिद्धान्त) (ब्रह्मसिद्धान्त).—The record of the authentic *Sūtras*.

BRAHMA'NDA, (ब्रह्मन्दा) (ब्रह्मन्दा).—The mundane egg, created by *Brahma*—also the visible sky, which is supposed to be the shell of this egg.

BRAHMYA, (ब्रह्म्या) (ब्रह्म्या).—(written *Brahman* in the Text).—The Vega Star of the 25th Lunar mansion, a *Pegasi*. Vide p. 74.

BRISYA, (ब्रिष्य) (ब्रिष्य).—called *Vishu* in the Carnatic.—The 13th year of the cycle of Jupiter. Vide I Chr. Table.

BRITASTA'N, (ब्रितस्तान) (ब्रितस्तान).—Mentioned in the *Brahmāṇḍa Purāṇa*, as the place of religious duty, is supposed by some, to be the Island of Great Britain. It is also called *Svīta dīp*, or the White Island.—*Suvarṇa dīp*, or the Golden Island, is conjectured to be Ireland. The British Islands are (it is pretended) sometimes called *Chandra dīp*; and likewise *Trīcātara*, or the Island with three Peaks, viz. *Rajātātā*, *Ayātātā*, and *Suvarṇa vīta*.

BUDHA, (बुध) (बुध).—One of the names of Mercury—also a godhead, the founder of a religious sect, which is followed in different parts of India, and in all China. The epoch of the institution of *Budha's* religion is referred to the year 540 before Christ. According to Hindu Mythologers, he was the son of *Sōma* (the Moon) and the head of a dynasty, called on that account, the *Lunar line* of Princes. He flourished in the beginning of the *Treta yug*. Modern commentators place his birth in the year 1424 before Christ.—*Budha-vara*; Wednesday. Vide p. 6.

C

CACSHA, (कक्ष) (कक्ष).—The orbit of a Planet, or the circle which ancient Astronomers called the *Deferent*; for the *Gucsha* carries Epicycles, (*Paridhis*) like the *Deferent*. This term is alluded to at p. 84 and 85 of the Text, and 247, Hd Appendix.

- CAL'A**, (५३२)—An arc of one minute of a degree; also the Phases of the Moon, of which the Hindus count 16.—*Mahā Calā*; the conjunction or opposition of the Sun and Moon; vide p. 77.—*Legā Calā*. Vide p. 102.
- CAL'A'NILAM**, (३०६०००)—One of the elements of the *Vācyam* (spelt *Vakiam* in the Text) process, and containing 3031 days.
- CAL'LAYUCHI**, (३०५५५५)—The 32d year of the cycle of Jupiter. See I Chr. Table.
- CALI**, or **CALCI**, (५३, ५३)—The 10th Incarnation of *Vishnu* in the shape of a Horse with a human head; vide p. 311.—Its anniversary noticed in the Calendar.
- CAL'YUG**, (५३५५५५)—The fourth of the periods contained in a *Mahayug*. The Iron age—consisting of 432000 Solar Syderal years. Its epoch, i. e. that of its beginning, ascends to 3102 years before the Christian Era. Vide *Crita yug*, also p. 7, 8, 77, 222, 228, 293, 302, Table LI, p. 68, and I and II Chr. Tables.
- CALPA**, (५३५)—literally *Form*.—The grand period of general conjunction. It consists of 432000000 Solar Syderal years; being the sum of 14 *Manwantaras*, with a *Sandhi*, or twilight of 1728000 Solar years; vide *Manwantara*; also p. 77.—*Calpa dina*, the day on which the *Calpa* began, or its anniversary, which is noticed in the Calendar. Vide p. 319.
- CANYA**, (५३५)—The Hindu Solar Sign *Virgo* ♍. Vide p. 5, and Table III.
- CARCA'TACA**, (५३५५५५)—(spelt in the Text *Carcata*).—The Solar Sign *Cancer* ♋. Vide same pages as above.
- CARANA**, (५३५)—(spelt in the Text *Carna*)—An astrological element importing the time during which the Moon's motion from the Sun amounts to 6°: there being 2 *Caranas* in one *Tithi*.—The Moon's synodical revolution is divided into 11 *Caranas*, 7 of which are *wachinac* and moveable, called *Chara*; and 4 extraordinary and fixed, called *Sthirca*—the time when the successive *Caranas* end, is inserted in the Ephemerides. Vide p. 73, 75, 79, 307.
- CARNA**, (५३५)—The hypotenuse of a right angled Triangle—*Chala carna* (spelt *Chita carna* in the Text) the *true* distance of a Planet from the Earth, in contradistinction of its *mean* distance, represented by the Radius of the Deferent. When this term is so understood, the *Sudh'a cati*, and *Bhujajya*, form the other two sides of a right angled Triangle; vide *Iks' carna*, also p. 96, 98.—*Carna mārḡām*; a straight, or perpendicular line; also a ray of the Sun.
- CARTICAY**, or **CARTIGA**, (३०६०००)—The 7th Hindu Solar month, when the Sun is in the Sign *Tula* ♎, answering to the Tamil *Arpaci*.—In the Southern parts of the Peninsula the Tamil month which is called *Cartiga*, is the 8th of the Solar year; care must therefore be taken not to confound these two *Carticaya*. In the Text the Southern name is invariably given to the 8th Tamil Solar month.—Lastly, *Carticay* is also the 8th Lunar month of the *Luni-solar* year. Vide p. 5, 69, and Table III.

of the Gannon; vide p. 84, 91, 94, 126, 189.—*Ch'haya rupa*; one of the names of Saturn, meaning *Born from Darkness*.

CHITRA, CHAITRA, and CHAITRAM, (చిత్ర, చైత్ర) —The 1st month of the Tamil Solar year, (always spelt *Chaitram* by F. Bechi, and in the Text) answering to the Hindu *Vaisac'h*a, when the Sun is in the Sign Mesha γ .—But this name is that of the last month of the Hindu Solar year used every where (excepting in the land of Tamil,) when the Sun is in the Sign Mitha κ , answering to the Tamil Pongoni: a circumstance which must be carefully attended to; vide p. 5, and Table III.—Lastly, *Chaitra* is the name of the 1st month of the *Lunar solar year* which begins on the new Moon preceding the Sun's entrance in the Sign Mesha γ ; vide p. 60.—N. B. This variety of significations of the same term or rather of terms so nearly resembling each other, requires the greatest attention, when adverting to dates, and reading books written in different countries.

CHITRABHANU, (చిత్రభాను) —The 16th year of the cycle of *Jupiter*. Vide I Chr. Table.

CHOUTI, (చౌతి) —The 4th day of the Lunar *Pachha* or demi-lunar month. Vide p. 70.

CELACA, (శిలక) —(the C to be pronounced hard) —The 42d. year of the cycle of *Jupiter*. Vide I Chr. Table.

CIMASTUGHNA, or **RHIMUSTOGUNA**, (శిమస్తుగ్గున) —(the C to be pronounced hard) —The 11th and extraordinary *Carana*. Vide p. 75, 318.

COTI, (కోటి) —The complement of an arc to 90° ; also one of the sides of a right angled triangle.—*Suddha coti*; the sine.—*Cotijya*, the cosine of an angle in such a triangle.

CRADI or **CRODHI**, (క్రాది) —The 38th year of *Jupiter's* cycle. Vide Chr. Table I.

GRAMAJYA, (గ్రామజ్య) —The sine of a Planet's declination.—*Paramaphau-gramajya*, the sine of its greatest declination, (written *Paramjya* in the Text). Vide p. 92.

CRANTAM, (క్రాంతం) —(in the Text *Crantam*).—An astrological element, explained at p. 308. Vide also p. 76 and *Kalendar*.

CRANTI, (క్రాంతి) —literally, *ascending, surmounting*;—astronomically, *declination*; vide p. 5, 84.—*Cranti bhaga*, the declination of a point of the *Ecliptic*; vide p. 91, 97.—*Cranti racsha*, or *mandala*, the *Ecliptic*; vide p. 91.—*Cranti jya*, the sine of the declination; vide p. 105.—*Cranti pada*, literally the Nodes of the *Ecliptic*, or the *Equinoctial points*.—*Cranti Pada-Gati*, literally the motion of the Nodes of the *Ecliptic*, but more precisely what Europeans call *precession* or variation. Vide p. 86, 237, and refers to the whole of Appendix II.

CRISHNA, (కృష్ణ) —One of the *Avatāras*, or descents of *Vishnu*; supposed to have lived at the time when *Fudhish'hira* flourished, but whose epoch, according to Mr. Bentley, descends to A. D. 900. As *Vishnu* is a personification of time, so is his identical incarnate being.—As a hero, *Crishna's* feats are recorded in the *Mahābhārata*, a celebrated poem describing a fictitious war.—The anniversary of this incarnation is noticed in the *Kalendar*. Vide p. 311.

CRISHNA PACSHA, (కృష్ణపక్ష) —The latter, or dark half of the Lunar month; also called *Bahula pachha*. Vide p. 66, 314, 320.

CRITA YUG, (కృతయుగ) Vide *Satya yug*.

CRITICA, (కృత్తిక) —The 3d Lunar mansion. Vide p. 74.

CRODHANA, (కృద్ధన) —The 30th year of *Jupiter's cycle*. Vide Chr. Table I.

CSHAIA, (క్షయ) —To *wane*, to *waste*, to *decline*.

CSHAYA, (క్షయ) —Derived from *Cshai*. —*Cshaya tilhi*, an expunged Lunar day. —*Cshayamasa*. Do. Lunar month. —*Cshaya samvatsara*, a luni-solar year with two intercalary and one expunged months. —*Cshaya Paraharipati mana*, a year expunged out of *Jupiter's cycle* of 60 years. Vide p. 84, 68, 71, 72, 75, 79, 137, 142, 206, 209, 301, and III Chr. Table.

CSHETPA, (క్షేప) —A constant number to be added in certain computations to fit a particular epoch; in consideration of *Siddhya* which is to be subtracted. Vide Pr. p. xi, Text p. 51, 203, 230.

CSHESHNA, (క్షేషణ) —The part of the Moon's disc obscured in an Eclipse. Vide p. 343.

CSHETRA GANITA, (క్షేత్రగణిత) —Geometry. —*Cshetra Dersa*. A treatise of.

CSHITPA, (CACSHA), —(క్షితి, క్షి) —The horizon. —*Cshitijya*, the sine of an arc referred to the horizon, used for finding the ascensional difference. Vide p. 91, 98, 105.

CSHYA, (క్షయ) —The 60th year of *Jupiter's cycle*. Vide Chr. Table I.

CUJA, (కుజ) —One of the names of the Planet *Mars*.

CUMUTIA, (కుంభ) —The Hindu Solar Sign *Aquarius* \equiv . Vide p. 5 and Table III.

CUMERU, (కుమేరు) —The Southern hemisphere, or Pole—a fabulous region where *Tama* presides over the *A'surâs* and *Daityas*. (Vide *Samera*).

CURMA, (కూర్మ) —The 2d Incarnation of *Vishnu* in the shape of a *Tortoise*. Vide p. 311.

D

DACSHA SAVARNI, (దక్షసావర్ణి) —One of the 14 Patriarchs who preside successively over the 14 *Manvantaras* of the *Calpa*. Vide p. 311.

DACSHIN'A, (దక్షిణ) —The South point of the compass.

DAITYAS, (దైత్య) —Vide *Asurâs*.

DANDA, (GHATICA), —(దండ) —The 1-60th part of a day, so called in the mode of dividing time called *Murta*. Vide p. 2, 77.

DARSA'NA, (దర్శన) —Intuition. —*Ananta daršana*, infinite knowledge.

DESA, (దేశ) —A country or region. —*Niraraha dés'a*, the Equatorial parts of the Earth.

DESAMI, (దశమి) —The 10th Lunar day of the *Pacsha*. Vide p. 70.

DESANTARA, (దేశాంతర) —The distance of any two meridians or the surface of the Earth; or what Europeans call *Longitude*. —Also the difference of *Longitude*, or allowance made for a Planet's proper motion, between the time of its being upon the first meridian, and its coming to that of a given place. But this is not to be understood in the same sense as what Europeans call the *Longitude*

of a Planet. Vide *Sayana*, also p. 95, 107, 109, 130, 131, 134, 135, 338, and Tables XXXIII, XXXIV and XLVII.

DE'VARAM, (దేవరం)—An element of the *Vacyam* process containing 235 natural days. Vide p. 121, 132, 133, 335, and Table XXVI.

DEVATA'S, (దేవతాః)—Benign spirits governed by *Indra*, properly the inhabitants of the North Pole; for the *Dévalās* are said to have day, when the *Daiṭyās* have the night, and vice versa. Vide *Surāṣ*.

DEVĪ, (దేవి)—A term used in the *Kalendar* to signify *day time*. Thus *Tyājyā Devī* (wrongly spelt *Thyagyan* in the Text) means that the *Tyājyā* occurred at day time. Vide p. 75, and Appendix IV.

DHANA, (ధనం)—The sign of affirmation, or addition, of the same import with + or plus.

DHANISH'TA, (ధనిశ్ఠా)—The 23d Lunar mansion. Vide p. 74.

DHANUH, DHANUS, or CHAPA'M, (ధనుః, ధనుస్) —An arc of a circle.

DHANUR MARGAM, (ధనుర్మార్గం)—A curve line.

DHANUS, (ధనుస్)—The Solar Sign *Sagittarius* ♐. Vide p. 5, and Table III.

DHATA, (ధాతా)—(Vide *Ghatā'caṇḍas*, and p. 5.)—Dhāta, the 10th year of the cycle of Jupiter. Vide Chr. Table I.

DHANWANTARI, (ధన్వంతరి)—The celestial Physician, who was produced by the churning of the ocean.—Time.

DHRĪTI, (ధృతి)—The Yoga Star of the 8th Lunar mansion, δ Cassio. Vide p. 74.

DHRUVA, (ధ్రువం)—Generally the Pole of a great circle of the Sphere—Particularly the Celestial Poles.—*Uttara Dhruva*, the North Pole; also the *Polar Star*.—*Dacshin'a Dhruva*, the South Pole.—This term is also used to signify a constant arc, referring to the distance of a Planet from the beginning of the Sydercal Zodiac.—*Dhruvā* means more commonly an epoch to which a computation is referred. Lastly, it is the name of the Yoga Star of the 12th *Nacshatra*, supposed to be the same as β *Leonis*. Vide p. 74, 85, 123, 133, 144, 152, 162, 230.

DIC, (దిక్)—(wrongly spelt in the Text *Dikas*)—The four cardinal points of the compass.—*Astā dic*; the 8 principal points including the cardinal ones; and wrongly stated in the Text at p. 92, to mean only the 4 intermediate points.—The *Asta dic* are called the eight corners of the world, over each of which a divinity is supposed to preside. Vide p. 92.

DINA, (దినం)—A day, considered in a great variety of ways and durations, of which the following are the principal. : 1^o A *Sāvana*, or *Bhānti sāvana* din: A natural day, being the time between two Sun risings. 2^o A *Saura* din; of these there are two kinds; and the similarity of the name tends to confuse much the beginners in the study of Hindu Astronomy. First; the absolute sense of *Saura*, being *Sydera*l, the *Saura* dina is the time between the same point of the Ecliptic rising twice; or, more precisely, the time between the Equinoctial points rising twice. Second, the other *Saura* dina, is the time which the Sun takes to describe one degree of the

Ecliptic. It follows therefore, that strictly speaking, neither of these kind of days are equal throughout the year; yet the former, (which is also called *Nakshatra dina*) are supposed to be so in the first steps of several operations. Such is also the case with the latter, but this only happens when calculating the mean elements of the Planets by the *Varyam* process. 3^o *Diva dina*, is equal to a Syderal revolution of the Sun. 4^o *Pitrya dina*, to a Synodical revolution of the Moon. 5^o *Brahma dina*, is equal to a Calpa, or 4320000000 years, his nights being equal to his day.—*Yuga dina*, is another word for *Aharzana*, meaning the number of days expired from the commencement of a *Yug*.—Lastly, *Yuga dina* means the anniversary day of that on which a *Yug* began, which is always noticed in the *Kalender*.—N. B. This term is to be found in every part of the work, and therefore needs not be particularly referred to. Vide, however, p. 5 and 77.

DIN.A'RDHA, (दिनार्द्ध)—Half the time of the Sun being above the horizon. Vide p. 93, 106, 318.

DUADESI, or DWADESI, (द्वादशी)—The 12th day of the *Pacsha*, or demilunar month. Vide p. 70.

DUNDUBHI, (दुन्दुभि)—The 56th year of Jupiter's cycle. Vide Chr. Table L.

DURGA, (दुर्गा)—A personification of the Solar year.

DWA'PARAYUG, (द्वैपरयुग)—(wrongly spelt in the Text *Desapar yug*).—The third of the periods contained in a *Mahā yug*. Its duration is of 864000 *Saura* years. The *brass* age of the *Hindus*. Vide p. 7, 77.

DWIJYA', (द्विज्या)—The Sine; but more properly the Chord of an Arc; vide *Jiva*.—Also the Sine of the Sun's declination when his Longitude is II Signs. Vide p. 101.

DWIJYA' MARGAM, (द्विज्यामार्गम्)—An horizontal line.

DWIJYA' PINDA', (द्विज्यापिण्डः)—The Sine of 3° 45'; vide *Pinda*, also the whole of Article 8 of Part I of the *Key* to the *Siddhanta Chandra mana*; and Table XXX, p. 39 of the *Tables*.

DWIPA, (द्वीपः)—An extensive region or continent.

G

GANDA', (गन्धः)—The *Yoga* Star of the 10th Lunar mansion, *Regulus*. Vide p. 74.

GA'NESA', (गणेशः)—One of the names of the god of wisdom.

GANITA S'A'STRA, (गणितशास्त्रम्)—Astronomy. A treatise of.

GARGA, (गर्गः)—An ancient Astronomer; the *Guru*, or instructor of *Yudhisht'hira*, one of the Princes of the *Lunar* line.—That *Garga* was cotemporary with *Yudhisht'hira* is contested by some modern commentators, who assign the year 546 before Christ for the time when he flourished.

* GARUDA, (गरुडः)—The Bird of Vishnu. An epithet of the Sun; but not admitted by the *Madras* Pundits.

GATI, (गतिः)—Generally, motion.—Specially, the diurnal motion of a Planet in its orbit; vide p. 88, 89, 107, also *Tables* XX, XXI for the Sun and Moon, and the first part of *Tables* XLI, XLII, XLIII,

XLIV, XLV for the daily motion of *Mars, Mercury, Jupiter, Venus, and Saturn*.—*Madhya Gati*; mean motion.—*Sphuta Gati*; true or apparent motion.

GAUN'A CHANDRA MASA, (గణపాంశ్రమాసం)—The Lunar month when it begins at the full Moon, called secondary.

GHATICA, (గడిక)—An Indian hour, 24 minutes European time, (vide *Danda*).

GRAHA, (గ్రహం)—The Planets.—A moveable point in the heavens. The Planets have each a great number of names, or epithets; many of which are to this day unknown to Europeans. The following, however, are known to every Indian, because they serve to give a name to the seven days of the week: 1^o *Ravi*, or *Surya*; the Sun. 2^o *Chandra*, or *Soma*; the Moon. 3^o *Mangala*, or *Gaja*; Mars. 4^o *Budha*; Mercury. 5^o *Guru*, or *Vishnupati*; Jupiter. 6^o *Sukra*, or *Bhargu*; Venus. 7^o *Sani*, Saturn. Vide p. 6.—Besides these, the Hindu Astronomers consider *Rahu*, the Moon's ascending, and *Ketu* her descending Nodes, as obscure Planets, which occasion the Eclipses of the Sun and Moon. Vide p. 308.—The Tables from XLI to XLV give the mean motion, Anomalistic equation and Annual equation of the five Planets known to the Hindus.—*Graha*, when the terms *Madhya* and *Sphuta* are prefixed to it, signifies the mean, and apparent place of the Planet in the Hindu Syderal, or fixed Zodiac. Vide p. 83, 87, 280.—*Graha laghava*; a treatise on Astronomy, written about the 4627th year of the Cali yug (A. D. 1555.)

GRAHANA, (గ్రహణం)—General term for an Eclipse; vide p. 343.—(*Grahana tinoooria padhi*, a term used by common Kalendar makers for half the duration of an Eclipse, but the word *Tinooria* is not recognized by the regular Saastries). Vide p. 345.

GRAHA PARIVRITHI, (గ్రహపరివర్తిత)—An account of time used by the inhabitants of the Southern Provinces of the Peninsula of India. It consists of a cycle of 90 Solar Syderal years of 3654 13^h 31^m 30^s Indian, or 3554 6^h 12^m 36^s European time. Vide p. 31, 295, 302, 303, and Table II, p. 2 of the Tables.

GRISHMA, (గ్రీష్మం)—The 2d Season of the year, comprehending the months *Jyestha*, and *Ashadha*, when the Sun is in the Signs *Vrisha* ౪, and *Midhuna* II; answering to the Tamil months *Vaissei* and *Auni*. (*)

GUDIYA, GHATICA, (గుడియ, గుడిక)—(as it is all this work *Guddia*)—*Ghetica*, the Sanscrit, and *Gudiya*, the Telugu, names of a space of time equal to 1.60th part of the natural day, or 24 minutes of European time: the same as a *danda*. It is divided sexagesimally into *vigudiya*, *paras*, *zurur*, &c. The *Gudiya* referring to time, must be distinguished from an arc of the same name, which divides a Lunar mansion, or *Nacshatra*, (13° 20') into 60 parts, subdivided likewise sexagesimally as the measure of time into *vigudiya*, &c. Vide p. 6, 77.

(*) It has been observed at page 4 in the note (*) that the Tamils reckon their Seasons to begin one month later than the rest of the Hindus; so that in the present case the Tamil Season of *Grishma* would comprehend the months of *Juni* and *Juli*. In order not to perplex the reader's attention by multiplied explanations, the present observation will not be repeated in the other articles which refer to the Seasons.

GURU, (గురు) — One of the names of Jupiter; also a spiritual guide, preceptor, teacher, &c.—*Gura vara*, Thursday. Vide p. 6, and Table XLIII.

H.

HARAM, (హరం) — The denominator of a fraction.

HARSHANA, (హర్షణ) — The *Yoga* Star of the 14th Lunar mansion, *Spica Virginis*. Vide p. 19, 74.

HASTA, (హస్త) — The 15th Lunar mansion. Vide p. 74.

HEMALAMBA, or HEVILAMBI, (హేవలంబి) — The 31st year of the cycle of Jupiter. Vide Chr. Table I.

HEMANTA, (హేమంత) — The 5th Season of the year, comprehending the months of Margasiras and Pausnya, when the Sun is in the Signs *Vrishchika* ♏ and *Dhanu* ♐, answering to the Tamil months *Cartiga* and *Margali*.

HORA, (హోర) — The 1-24th part of the natural day, answering to an European hour. A measure of time probably introduced in India by the Europeans.

I.

ICSHWA'CU, (ఇక్ష్వకు) — The first king in the Solar line, who reigned at the commencement of the *Treta yug*. He was the son of the 7th *Manu*, or Patriarch, the offspring of the *Sun*. His posterity was called in consequence, the dynasty of the *Solar Princes*, in the same manner as *Budha* was reputed the head of the *Lunar* line. Modern commentators bring the time of his accession down to the year 1320 before Christ. Vide p. 311.

INDRA (MAHA'), (ఇంద్ర) — The god of thunder; a personification of the sky—The chief of the *Dévas*, or *Suras* (vide *Dévas*);—also, the *Yoga* Star of the 26th *Nacshatra*, *γ Pégasi*. Vide p. 74.

INDU, (ఇందు) — A name of the Moon. That name is commonly given to her when that of *Arca* is applied to the Sun; or in a compound form. (Vide *Arc'anda Sangama*).

IS'WARA, (ఐశ్వర) — The 11th year of the cycle of Jupiter. Vide Chr. Table I.—Also, an epithet of *Siva*. (Vide *Siva*).

ITIEK, (ఇత్యేక) — Two syllables added by certain Southern Astronomers, to the name of a Lunar month when it is an intercalary one. Thus *Phalguna-Itiek* indicates that the said Lunar month is to be repeated. This term is a compound of *Iti*, this is; *ek*, one; signifying that the month so named is that which is *truly intercalated*, the month *Phalguna* which precedes it, being the *Nija* or proper one. In the Carnatic, however, the same month would be called *Athica Chitra*, and the following *Nijah Chitra*, the first being that which is intercalated; so that according to either denomination the intercalated month is the same.

JAISH'THA, (జ్యేష్ఠ) — The second month of the Hindu Solar year, when the Sun is in the Sign *Friska* ♉, answering to the Tamil month *Purattasi*. Vide p. 5, and Table III.

JAMBU DWIPA, (జంబు ద్వీప) — One of the seven grand divisions of the Earth, including Asia; so named from the tree called *Jambú* abounding in it. — Modern commentators, however, pretend that it refers only to certain parts of the interior of Asia. — The *Eden* of the Hindus.

JAMNA PATRICA, (జన్మపత్రిక) — What Astrologers call the *Nativity*. — The aspect of the Planets in the heavens, at any proposed instant of time.

* **JANU**, (జాను) — Literally means the *Knee*. It is therefore difficult to understand why in some places it is used as an epithet of the Sun.

* **JANU SEPTAMI**, (జానుశ్చమి) — In some books is a term used to indicate the beginning of the year; but it is unknown as such to the Pandits of the Carnatic.

* **JARA'SAND'HA**, (జరాసంధ) — The name of a celebrated king who reigned in *Magadha*, the head of a dynasty which followed that of the Solar and Lunar lines.

JIVA, (జీవ) — (sometimes written *Jya* or *Jaya* in European books on Hindu Astronomy.) — The Chord of an Arc; but frequently written for *Artha-jya*, "half the String of the Bow", which comes to the same as our definition of "half the Chord of double the Arc." Vide p. 92, and Table XXX, with demonstrations from p. 39 to 42 of the Tables.

JYA' PINDA'S, (జ్యోతిషంధ) — The Sines of the 24 *Pindas* ($3^{\circ} 45'$ each) into which the Quadrant is divided. Vide as above.

JYA'TACA, (జ్యోతక) — Astrology. — A Horoscope. — *Jyātaca Śāstra*. A treatise on,

JYEST'HA, (జ్యేష్ఠ) — The 18th Lunar mansion. Vide p. 74.

JYO TISH-SA'STRA, (జ్యోతిషశాస్త్రం) — Any treatise on Astronomy. — *Jyōtish Śāstrī*, a title assumed by the Indian Astronomers, (always wrongly spelt in the Text *Jyautish Sastras*). Vide Pr. p. lii, and Text p. 281.

JYOTISHTAVA, (జ్యోతిష్టవ) — A treatise on Astrology. Vide p. 197, 200, and Tables XIV and XIX.

K

KA'LA, or **GA'LA**, (కాల) — (always written *Kala* in the Text). — Time in its natural acceptation. This term, as it sounds to the ear, is applied to a great variety of mathematical and astronomical subjects, several of which may be collected out of the expositions contained in this Glossary.

KATAPAYA'DI, (కటపయోది) — Special Arithmetic; of the same import as Algebra.

* **KAUSTUBHA**, (కౌస్తుభ) — An epithet of *Vishnú*. A sparkling gem, worn by that deity; elicited by the churning of the ocean; it is in some places taken as an emblem of the Sun; but the Pandits of the Carnatic do not admit of that allegory.

KE'NDRA, (కేంద్ర) — and (according to Sir Wm. Jones' orthography) *Cendra*. — Answers to what Europeans call the argument of an equation. — *Patana cendra*, the argument of the latitude. — *Dvitiya cendra*, the supplement to a whole circle of what Europeans call mean anomaly; being the distance of the higher Apis, from a Planet in any point of its orbit. — *Sighra cendra*, the commutation;

being the distance of the Sun from a superior Planet; or the distance of an inferior Planet from the Sun.—*Mandacānda*, the argument of anomaly. Vide p. 87, 88 and other places.

RETU, or CETU, (𑂔𑂗𑂢𑂰)—The Moon's descending Node. Vide *Grāha*, also p. 77, 308, 310.

KRITA, or GHITA YUG, (𑂔𑂰𑂩𑂰𑂩𑂰𑂩𑂰)—The same as *Salga yug*; the golden age of the Hindus; which consists of 1728000 Solar Syderal years; being the first of the four periods contained in a *Manu yug*. Vide p. 7, 77.—N. B. Some Astronomers and Commentators, reverse the numerical order of these *yugs*, and would therefore call this the fourth.

L

* LACSHMI, (𑂔𑂰𑂩𑂰𑂩𑂰)—The name of the goddess of wealth.—This word applies to a multitude of objects; too numerous to be repeated. In some parts of Northern India *Lacshmi* is a personification of the Luni-solar year; in the same manner as *Durga* is that of the Solar one; but this allegory is rejected by the Pandits of the Carnatic, who likewise deny what some pretend, that she lends occasionally her name to the Moon, and even to Jupiter.

LAGNA, (𑂔𑂰𑂩𑂰)—The Arc of the Equator which passes the Meridian in the same time with each Sign of the Ecliptic; and as *Lanka* is supposed to lie under the Equator, its *Lagna*, is called *Madhya lagna*.—*Lagna bhāga*, means the Ascensional difference. Vide p. 92, 101, 102, 103, and Table XXXII.

LAMBA, (𑂔𑂰𑂩𑂰)—The Co-latitude, or the Arc between the Pole and Zenith of a given place.—*Lambajya*; its Sine, or the Cosine of the Latitude. Vide p. 94.

LANCA' (𑂔𑂰𑂩𑂰𑂩𑂰)—One of the four imaginary cities which are supposed to lie under the Equator at 90° distance from each other; viz. 1^o *Yamcoti*; 2^o *Lanca*; 3^o *Ramena*; and 4^o *Siddhapuri*. At page 9 of the Text, *Barnacoti* was stated to be the 3d.; but the Pandits have rejected that spelling.—*Lanca* is considered by all manner of Indian Astronomers, to lie under the first Meridian: to which all computations should be referred; though several (and particularly the *Telugus*) refer to that of *Ramēswara*. Towards the North, and under the same Meridian as *Lanca*, the *Sastris* state that there are two other cities and a great mountain, viz. *Avanti* (supposed to be the same as *Ujani*, or *Oogria*), *Rohitaca*, the mountain, and *Sannidha sarah*, which in former, or rather fabulous times, were the seats of Colleges and Observatories. The Meridian of *Lanca* lies in 75° 53' 15" (44 3' 33") East of Greenwich; and 73° 33' (44 54' 12") East of Paris. Vide p. 2. N. B. all the operations contained in this work which always refer to that Meridian.

LATTA, (𑂔𑂰𑂩𑂰)—An element of astrology. Vide p. 76, 309, and Appendix IV.

* LIBITA, (𑂔𑂰𑂩𑂰)—(*Mandala Yogarda*).—The side of a Spherical Triangle, with the argument of the Latitude of a Planet, and its Latitude for the other two.—N. B. The Tamil Astronomers resolve this Triangle as one of plane Trigonometry, and use it for finding the *Cak'itana*, or quantity of the digits obscured in an Eclipse.—*Libitangula*; digits referred to the same. Vide p. 342, 343.

LILA'VATI' GAN'ITA, (లిలావతిగణితం)—A general term for the science of the mathematics, of which it is said that the best known treatises are those of *Ārya-bhaṭṭa*, and *Bhāscara*; which may be correct for this part of India, where few original books on the sciences are to be found.

LIPTA AND VILIPTA, (లిప్త, విలిప్త)—Measure of time (vide *Vicāla*) equal to one minute and one second.

LO'CAS, (లోకం)—Fourteen Spheres, imagined to be allotted for the residence of different species of animated beings. The seven superior Lōcas are, 1^o The *Bhu, lōca*, or surface of the Earth. 2^o *Bhūva*. 3^o *Sivarga*. 4^o *Maha*. 5^o *Jana*. 6^o *Tapa*; and 7^o *Satya lōcas*.—The inferior Lōcas are, 1^o *Atala*. 2^o *Vitala*. 3^o *Satala*. 4^o *Tātātala*. 5^o *Mahātala*. 6^o *Rasātala*; and 7^o *Patāla lōca*.

M

MACARA, (మకరం)—The Hindu Solar Sign *Capricornus* ♑. Vide p. 3, and Table III.

MADHYA, or **MADHYAMA**, (మధ్య, మధ్యమ)—Signifies mean, in contradistinction to *Sphuta*, for true or apparent.—*Madhyama grāha*, or *gati*, mean place or motion of a Planet; vide p. 1, 83, 85.—*Madhya c'hāyā*, the midday shadow of the Gnomon on any day of the year, excepting those of the Equinoxes. Vide p. 97.

MA'GH, or **MA'GHĀ**, (మఘ)—*Magh*, the 10th Hindu Solar month, when the Sun is in the Sign *Macara* ♑; answering to the Tamil month *Tya*; vide p. 5 and Table III.—*Maghā*, the 10th Lunar mansion. Vide p. 74.

MAHA, or **MAHE**, (మహా)—Great.—*Maha yug*, a great period of conjunction or opposition.—*Mahā Indra*; the great *Indra*, &c.

MAHA'BHĀ'RATA, (మహాభారతం)—An historical poem of great celebrity; in the first book of which is given an account of the war between the *S'uras*, and *As'uras*, in which the gods intervened. This poem is interesting to Astronomy, because it records the first Eclipse of the Sun mentioned in any of the *Sastras*. Modern European commentators suppose that it was written in the year 786 of the Christian Æra, and that the date of the Eclipse which it records is the 23th October in the year 945 before Christ, and therefore anterior to that transmitted to us from the *Chaldeans*, which was observed on the 19th March A. A. Christian 720.

MAHA YUG, (మహాయుగం)—A grand period of general conjunction, containing 4320000 Solar Sydereal years, and comprehending the four lesser *yugs*. Vide *Calli*, *Dvapara*, *Treta* and *Satya yugs*; also p. 7, 77.

MALAYALA, (మలయాళం)—The name given to the lands which extend from *Mangalore* to *Cape Comarin*, following the Coast of *Malabar*. Vide p. 130, 298; of Chr. Tables, p. vi and Table I.

MALLI CA'RJANADU, (మల్లికార్జునపుడు)—(wrongly spelt in the Text *Mulla Cerjanada*)—A Telugu

Astronomer, who is supposed to have flourished in the 4279th year of the Cali yug (1100 Saca) who like *Bāla ditya* referred his computations to the Meridian of *Ramizara*. Vide p. 9.

MA'NA, (मनः)—Generally a *Measure*.—In Astronomy a mode of reckoning the duration of the year, whether as *Saura*, *Chandra*, *Savana*, *Nāśatra*, *Varahspatya*, *Brahmya*, *Dayoga*, *Pāriya*, or *Prīṇputya*.—The principal mode of reckoning the year as now practised by the Hindus is, either Solar, or Luni-solar.—The Solar is the time which the Sun takes to perform a complete revolution round the heavens, beginning from a Star and returning to the same. The Solar Hindu year is therefore Syderal; but it is taken to be of various durations, according to the systems and authorities which are followed.—The Luni-solar year in most general use, or the common *Chandra manu*, consists of 12 or 13 Lunar months. It commences with the new Moon at, or next before the time when the Sun enters the first Sign of the Solar Syderal Ecliptic. Its months are called *Muc'hya* or primary.—The *Barhusputya* (wrongly spelt in the Text *Banu Husputtah*) *Chandra manu*, is another sort of Luni-solar year, which begins at the wane of, or the full Moon next preceding the Sun's entrance into the Syderal Ecliptic. Its months are called *Gama*, or secondary; vide p. 1, 57, 63, 77, and of Chr. Tables p. ix and Tables I and II.—The *Varahspati manu*, or Jupiter's year, is properly the time during which the Planet describes one Sign of its orbit. However, in the Peninsula of India, it is taken to be equal to the Solar year, and in present times serves only to give a specific name in a cycle of 60 years, to each Solar and Luni-solar year. Vide Third Memoir, p. 197, and Chr. Table I; also Samvatsara.

MANDA, (मन्दः)—What Europeans call Anomaly.—*Manda phala*, the Anomalistic equation of any Planet.—A name of *Saturn*; vide p. 87, 89, for the Sun and Moon, Tables XXII, XXIV, and XXIII, XXV; for the Planets, 11d part of Tables from XLI to XLV.

MAND'ALA, (मण्डलः)—A Circumference, a great Circle.—*Nādi mand'ala* (spelt *Nari* in the Text)—The Equator.—*Cakṣit mand'ala*, the Ecliptic. Vide p. 5, 91, 342.

MANDOCHA, (मण्डोच्छः)—The Apes of a Planet's orbit.—*Tunga mandocha*, the higher Apsis. Vide p. 11, 76, 83, 84, 154.

MANGAL'A, (मङ्गलः)—A name of the Planet *Mars*.—*Mangal'a vara*; Tuesday. Vide p. 5, and of the Tables the XL1st.

MANMATHA, (मन्मथः)—The 22th year of the cycle of Jupiter. Vide Chr. Table I.

MANUS, or MENU, (मनुः)—Fourteen Patriarchs who are supposed to preside successively over the same number of *Manvantaras* of which the *Calpa* is composed, and whose anniversaries are noticed in the Kalendar. Vide p. 311.

MANWANTARA, (मन्वन्तरः)—A period of 308448000 Solar Syderal years; of which there are $\frac{1}{4}$ in a *Calpa*, with a *Sandhya*, or twilight, equal to the *Satya yug*. Vide p. 77.

MARCANDA', (मरकटः)—An Astronomer who has left several useful Tables, of a modern date. Vide Pr. p. ix, Text p. 87, Tables XXIV & XXV.

- MARGALI, (మర్గశిర) —The 9th Tamil Solar month, answering to the Hindu *Pauthya*, when the Sun is in the Sign *Dhanus* ♐. Vide p. 5, and Table III.
- MARGASIRAS, (మర్గశిర శిర) —The 8th Hindu Solar month, answering to the Tamil *Cartiga*; when the Sun is in the Sign *Frishica* ♏. —This month is also sometimes called *Agrahayan*, a name which was given to it when it was made to begin the Solar year. Vide p. 5, 245, and Table III.
- MĀSA, (మాస) —(wrongly spelt *Masha* in the Text) —A month, whether Solar or Lunar, and consequently of various durations. —The first month of the Solar year is called in the *Sargah Siddhanta*, *Mēsha* *erisa*, because the Sun is then in the Sign *Mēsha* ♈, answering to the Hindu month *Vaisākh*, and Tamil *Chitān* (always spelt *Chaitram* in the Text). —It is also the first month of the common Luni-solar year, called *Chaitra* (whether it opens with the new or full Moon); and therefore, refers to two sorts of Luni-solar years. —The *Nacshatra Chandra masa* is the time which the Moon takes to move through a *Sydereal* revolution. —The common Lunar Kalendar month, *Do*, through a *Synodical* revolution. —*Devā masa*, 30 *Sydereal* years. —*Brahma masa*, 30 of his days. Vide *Māna*; also p. 5, 11, 53, 69, 77, and Table III.
- MATSYA DE VA, (మత్స్య దేవ) —One of the incarnations of *Vishṇu* as a *Fish*. Vide p. 311.
- MĀSĪ, (మసి) —The 11th Tamil Solar month; answering to the Hindu *Phalgunā*, when the Sun is in the Sign *Cumbhā* ♉. Vide p. 5, and Table III.
- ME'RU, (మేరు) —Seems to mean strictly the Terrestrial Orb; or yolk of the mundane egg.
- ME'SHA, (మేష) —The first Sign of the Solar *Sydereal* Zodiac, the Hindu *Aries*; vide p. 5, & Table III. —*Mēsha* *Ayanā*; the Vernal Equinoctial point (vide *Ayanā*).
- MIDHUNA, (మిథున) —The 3d Sign of the Hindu *Ecliptic* II, the Hindu *Gemini*. Vide p. 5, and Table III.
- MIBIRA, (మిరి) —An epithet of the Sun.
- MI'NA, (మీన) —The 12th Sign of the *Ecliptic* ♊, the Hindu *Pisces*. Vide p. 5, & Table III.
- MRĪGASIRAS, or MRĪGASIRSHA, (మృగశిర) —The 5th Lunar mansion. Vide p. 74.
- MUCHYA, (ముఖ్య) —A name given to the Lunar months of the common *Chandra masa*; meaning *primary*. Vide p. 148.
- MULĀ, (మూల) —The 19th Lunar mansion. Vide p. 74.
- MUNI, (ముని) —Supernatural Beings to whom *Suryah* (the Sun) revealed the science of Astronomy.
- MURTA, (మూర్త) —literally, the twinkling of an eye, —figeratively, a mode of reckoning small portions of time. —The *Nacshatra* days (all of which are supposed to be equal throughout the year) contains 60 *dandas* ÷ 60 *vicālās* ÷ 6 *prānācālās* ÷ 10 *astācālās*, or respirations. The latter answering, therefore, to a second of Hindu time ÷ 60 *alipālas* ÷ 3600 *nimashas*, &c. —N. B. The sexagesimal order is interrupted after the *vicālās*, which are only subdivided into 6 *prānācālās* for the purpose of procuring a numerical division of time equal to the number of minutes of a degree contained in the circumference of a Circle, being 21600. Vide p. 6, 22, 104.

N.

NACSHATRA, (నక్షత్రం) — Properly a Star: Hence the Sydercal year, month, or day, are called *Nacshatra* *ayatsara*, *masa*, or *dina*. — But that term means also a Constellation, and still more particularly, any one of the 27 mansions of the Moon; we shall especially consider the latter as article *Rishu*. A Lunar mansion contains an arc of $13^{\circ} 20'$ of the circumference of the Zodiac ($27 \times 13^{\circ} 20' = 360$), therefore a Solar Sign contains $2\frac{1}{2}$ Nacshatras ($\frac{360}{13^{\circ} 20'} = 2\frac{1}{2}$ Nacs.) — There are a fixed and a moveable Lunar, as well as Solar Zodiacs: therefore there are also fixed and moveable Signs, and Nacshatras, the motion of the latter being equal to the progress of the *Ayanansa* ($54'$ per annum, *Surya Siddhanta*). This distinction occasions, the same ambiguity, when Indian authors speak of these Signs and Nacshatras, as there is with us when we say that "*Aries* has got into *Taurus*". But they present this juxta position of the fixed and moveable Signs, in a manner quite different from ours. They would say that the advance of the Stars from West to East, being owing to the *Granti-Pata-Gati* (the Hindu precessional variation), it is the moveable Sign *Aries* which has receded from the Constellation, or fixed Sign of the same name, with which it formerly coincided; and consequently, that the Zodiacal Sign *Aries* has fallen back into the fixed Sign *Pisces*, which comes precisely to the same thing. But more scientifically, they would say that the *Rishis* have got into some point of the moveable *Aries*; (vide *Rishis*, *Ayanansa*, *Granti-Pata-Gati*.) — It needs hardly be added, that what is said here of the Solar Signs applies equally to the Nacshatras. — For the extraordinary Nacshatra, see *Abhijit*; vide p. 6, 73, 74, 176, 181, and Table XXXVIII. — *Nacshatra Chakra*; the Sphere of the fixed Stars.

NA'DIMAND'ALA, (నాదిమండలం) — (written in the Text *Narimandala*) — The Celestial Equator. Vide p. 9, 91.

NA'GAVA, (నాగవ) — The 10th and extraordinary *Carana*. Vide p. 75.

NANDANA, (నందన) — The 26th year of *Jupiter's* cycle. Vide Chr. Table I.

NARA', (నర) — The eternal omnipotent Being.

NARA'DIYA, (నారదీయ) — The name of an Astronomical work composed by *Narada*.

NARA'SIMHA, (నరసింహ) — The 4th incarnation of *Vishnu* as a Lion. Vide p. 311.

NARA'YANA, (నారాయణ) — A name or incarnation of *Vishnu*.

NA'YA (నయ) — The arc of distance of any Planet from the Zenith. — *Natani'a* or *Nata bhaga*, Zenith distance. Vide p. 91, 96.

NAVAMI, (నవమి) — The 9th Lunar day of the *Pacsha*. Vide p. 70.

NAZHI, or **NA'SHICAY**, (నాశి, నాశిచయ) — A *Tumil* term meaning an Indian hour of time. Vide p. 71.

NELA, (నెల) — In *Telugu*, a month.

NERMADA, or **NARMADA**, (నర్మదా) — A great River called in our Maps the *Nerbudda*, which from time immemorial has marked the boundary between Hindustan and the Deccan. It takes its source

near the Vindhya mountain in the Province of Malwa and flows into the Sea near Surat. This river is the same as that which Ptolemy calls *Nemadus*. The Indian name is a compound Sanscrit word, which signifies the river of delight; from *Nerma*, pleasure, and *Da*, she who bestows. Independently of the use made of this river in Geography, it serves also to separate two sects of Astronomers, who divide time on different principles. Thus whereas the *Vrihaspati* or Jupiter's year of the cycle of sixty, is reckoned at *Ogeia* and *Benares*, and down to the *Nerbudda*, to be equal to the time during which that Planet describes one Sign of its orbit, in all the Deccan, down to Cape Comorin, it is taken to be equal to a Solar year. And whilst all the Northern Astronomers reckon the latter to be of $365^d\ 6^h\ 12' \ 34''$, agreeably to the doctrines of the *Surya Siddhanta*, those who reside South of the *Nerbudda* make it only $365^d\ 6^h\ 12' \ 30''$; from this class, however, we must except that subdivision called the *Sittandij*, or inhabitants of the Southernmost part of the Peninsula, whose year differs only one second of time in *minutes*, from that of the Northern Astronomers. Vide *Pr.* p. ix; *Text*, p. 7; the *III^d* Memoir from p. 199 to 216, and *Chr.* Table I.

NIJA, (निजः)—Proper, self.—*Nija Asvina*, the proper month of *Asvina*, in contradistinction of *Athica Asvina*, the intercalated Lunar month. Vide p. 69, 72, 146, 312.

NIMESHA, (निमेषः)—The $\frac{1}{3600}$ th of an *Alipala* (vide *Alipala*), or the time for the twinkling of an eye. Vide p. 6.

NIRACSHA, (निरक्षः)—The Terrestrial Equator.—*Niracsha dha*, the Equatorial parts of the Earth.—*Niracsha-pura*, the four fabulous cities supposed to lie under the Equator, of which *Lanca* is one. (Vide *Lanca*).

O

For *Opady*, thus wrongly written in the Text, see *Uphadi*.

P

PACSHA, (पक्षः)—Half the Lunar month.—*Sukla* or *Sudha pacsha*, the time from the new to the full Moon.—*Crishna* or *Bahula pacsha*, that from the full to the new Moon.—Each *Pacsha*, whatever be the real duration of the Lunar month, contains 15 *Tithis*, or Lunar days, each being called numerically, so that there are two *Tithis* of the same name in the Lunar month. Vide p. 68, 69, 314, 318.

PA'DA, (पादः)—The fourth part.—The Quadrant of a Circle.—The *Paddas* of the *Agandans'a*; the four Quadrants of the Epleycle, or parts of the Arc described by the 1st point of the Tropical Zodiac in consequence of the precessional variation. Vide p. 81, 247, 248, 308, 313, and Tables XXXV and XXXVI, p. 46 and 47 of the Tables.

PA'DACHA'RUM, or **CHA'RUM**, (पादचरुम्)—(sometimes wrongly spelt in the Text *Ishurum*)—A term

used in the *Kalendar* and *Ephemerides* for signifying the position of the Planets on a particular day; being one of the five articles of the *Panchanga*. Vide p. 73, 75, 308.

PAD'YAMI, (పాదస్యమి) —The 1st day of the Lunar pasha, or demi-month. Vide p. 70.

PALA, (పల) —A minute of time, Hindu account.

PALABHA, (పలభ) —The midday Shadow of a Gnomon, when the Sun is in the Equinoctial points. Vide p. 9, 51, and Table XXXIV, p. 45 of the Tables.

PANCHA BHUTA, (పంచభూత) —The five elements of Nature, including *Ether*.

PANCHA'NGA, (పంచాంగ) —A *Kalendar* so called from the five principal articles contained in the *Ephemerides*.

PARA, (పర) —A second of time, Hindu account, or 24th European time.

PARA'BHAVA, (పరాభవ) —The 40th year of the cycle of Jupiter. Vide Chr. Table I.

PARA BRAHMA, (పర బ్రహ్మ) —A name, or epithet of the Supreme Being.

PARAMA'PAMA, (పరమాపమ) —The inclination of a Planet's orbit to the *Ecliptic*. —*Paramépana cramañga*, the Sign of its greatest Declination. —N. B. When this term is applied to the Sun, because according to Hindu theories the obliquity of the *Ecliptic* is always 24°, it means the Sine of the Sun's greatest declination.

PARA'SARA, (పరాశర) —An Astronomer who wrote when the Equinoctial points were in 23° 20' of the Sign *Mesha*. —Modern commentators pretend that the *Parásara Siddhānta* is a spurious treatise, written by *Arga bhata*, so late as the beginning of the XIVth century; and consequently cannot have been written by *Parásara*, who flourished about the year 575 before Christ.

PARAS'URA'MA, (పరశురామ) —One of the Avatars or incarnations of *Vishnu*, in the form of a Brahmin. —Modern commentators fix his epoch in the year 1176 before Christ. He is said to have been a great encourager of Astronomy. —Also an *Æra* which is still followed in *Malayála* (that part of the Coast of Malabar which extends from Mangalore to Cape Comorin). —This *Æra* is reckoned in cycles of 1000 years; each of which begins on the Sun's entrance in the Sign *Canya* (Indian Virgo). —There were, therefore, on the 14th September 1800, two cycles, and 976 years of that *Æra* expired. Vide p. 298, 302, and of Chr. Tables p. vi, vii, & Table I.

PARATASI, or PURATASI, (పరాతసి) —The 6th Solar month, Tamil denomination, answering to the Hindu *Atwina*, when the Sun is in the Sign *Canya*. Vide p. 5, and Table III.

PARIDHAVI, or PARIDHA'PI, (పరిధాపి) —The 46th year of the cycle of Jupiter. Vide Chr. Table I.

PARIDHI, (పరిధి) —Properly means the circumference of a Circle; but it is more generally used in the sense of an Epicycle. Thus *Paridhi an'sās*, or *bhagas*, mean degrees counted on an Epicycle, always in a given ratio, to those of the Deferent. —The *Manda paridhi*, is used for computing the first inequality or Anomalistic equation of a Planet. It is variable, being called *Fugma*

paridhi in the Apolder, and *Vaja paridhi* at 60° therefrom.—The degrees of these divers dimensions of the Epicycle vary therefore relatively to those of the Deferent, as the Planet's Anomaly is between the points above mentioned, decreasing inversely as the Sines of the mean Anomaly. At the distance of 3 Signs from either the *Apogee* or *Perigee*, the radius of the Epicycle becomes equal either to the *eccentricity*; or to the Sine of the *elongation*, if it refers to an inferior Planet.—This assumed difference in the magnitude of the Epicycle, (and consequently of its degrees relatively to those of the Deferent) is what the Hindus call *Paridhi an'śā*, between *Vishama*, and *Sama* (odd or even); for a right application of which we are to remember that from the 1st to the 3d Sign of Anomaly, a Planet is in *Vishama*; from the 3d to the 6th, it is in *Sama*; from the 6th to the 9th, it is again in *Vishama*; and lastly, from the 9th to the 12th, it is in *Sama*.—The *Sighra paridhi* is used for computing the second inequality, answering to the annual *Parallax* of the superior Planets, and *elongation* of the inferior ones. This Epicycle is also variable, being called *Yugmantara paridhi* in the *Sizigies*, and *Vojantara paridhi* at 90° therefrom.—*Swa*, *Seva*, or *Siva-desa-paridhi*, a Circle of Longitude in any given Latitude. Vide p. 91, 95, and Table XXXIV.

PARIGHA, (పరిగ్ఘ) —The *Yoga* Star of the 19th Lunar mansion. Uncertain; but supposed to be 34 or 35 *Scorpii*. Vide p. 74.

* PARIJATA, (పారిజాత) —The Tree of Plenty.—In some parts it is taken to be an emblem of the year; but this is unknown to the Pundits of the Carnatic.

PARTHIVA, (పార్థివ) —The 10th year of *Jupiter's* cycle. Vide Chr. Table I.

PASCHA, or PASCHAMA, (పశ్చిమ) —The West point of the compass.

PATA, (పాత) —The Node of a Planet's orbit. Vide *Ayanansa* and *Dhruva*, also p. 86.

PATAGA, (పతక) —An Astronomical Table.

PATANA, (పతన) —Latitude, when referred to the Planets.

PATRA, (పత్ర) —Literally, a *Leaf*; but used in several parts of India for *Panthanga*, a *Kalendar*; because these are usually published on *Palmyra* leaves. Vide Pr. p. vii, xii, and Text p. 312.

PAULASTYA SIDDHANTA, (పాలస్త్యసిద్ధాంత) —The third of the four authentic *Sāstras*, which treat of Astronomy.

PAUSHYA, (పౌష్య) —The 9th Solar Hindu month, when the Sun is in the Sign *Dhanus* ♐, answering to the Tamil *Margali*; vide p. 5 and Table III.—*Pauṣya* is also the 10th month of the Lunar-solar year, so advanced by one in the order, on account of *Chaitra*, beginning that sort of year. Vide p. 69.

PAVARNAMI, or PURNIMA, (పావనిమి) —The 15th Lunar day of the *Pacsha*. Vide p. 70.

PHALA, (ఫల) —An Equation.—When applied specially to the Sun or Planets, it means their Anomallistic equation.—*Phala try descentara*, is a compound equation used by the Tamil *Kalendar* makers for

computing, by means of certain Tables, and a short operation, the *Arca bahupala*, and the effects of difference of Longitude in Solar and Lunar computations. Vide p. 38, 230, 338, and Tables XXII to XXVI for the Sun and Moon, and from XII to XIV, part 2, for the Planets.

PHALGUNA, AND PHALGUNI, (ఫాల్గుణ) — *Phalguna* the 11th Hindu Solar month, when the Sun is in the Sign *Cambh'a* \equiv ; answering to the Tamil *Mausi*; vide p. 5, and Table III. — According to the Luni-solar Kalendar *Phalguna* is the 12th month of the year, because it begins with *Chaitra*; vide p. 69. — *Purva Phalguni* the 11th, and *Uttara Phalguni* the 12th Lunar mansions. Vide p. 74.

PINDA' (పిండ) — The 1-24th part of the Quadrant of a Circle; equal to $3^{\circ} 45'$, the constant ratio of the Hindu Trigonometrical Tables. Vide p. 87 and Table XXX.

PINGALA, (పింగళ) — The 51st year of the cycle of *Jupiter*. Vide Chr. Table I.

PITRI, (పితృ) — Certain Genii or Spirits, supposed to reside in a sphere or region, some say above the Moon; others residing in it. The *Pitris* are also taken to be the spirits of deceased ancestors. — *Pitrya dina*; a day of the *Pitris* equal to a lunation.

PLAVA, (ప్లవ) — The 35th year of the cycle of *Jupiter*. Vide Chr. Table I.

PLAVANGA, (ప్లవంగ) — The 41st of the same.

PUNGONI, (పంగుని) — The 12th Tamil Solar month, answering to the Hindu *Chitra*, when the Sun is in the Sign *Minu* \times . Vide p. 5, and Table III.

PRABHAVA, (ప్రభవ) — The 1st year of the cycle of *Jupiter*. Vide Chr. Table I.

PRAC CHACRA (ప్రాశ్చర్య) — The Epicycle on which ancient Astronomers corrected the precessional variation. Vide *Cranti. Pata. Gati*, and p. 84 of the Text.

PRA'JAPATI, (ప్రజాపతి) — A name of *Brahma*. — An epithet common to 10 divine personages who were first created by *Brahma*. — *Prājāpati*; the 5th year of the cycle of *Jupiter*; vide Chr. Table I. — *Prājāpatya māna*, a certain mode of reckoning the year; also, a *Manwantara*.

PRAL'AYA, or JALA-PRALAYA, (ప్రళయ) — A name for the universal deluge.

PRAMADI or PRAMADICHA, (ప్రమాద) — The 47th year of the cycle of *Jupiter*. Vide Chr. Table I.

PRAMAN'A', (ప్రమాణ) — Refers to diurnal revolutions. — *Aha prama'n'a*; the Sun's revolutions from the horizon to the same again. — *Dina prama'n'a*, the time of any Planet from rising to setting. — *Ratri prama'n'a*, the same from setting to rising.

PRAMODA, (ప్రమోద) — The 4th year of the cycle of *Jupiter*. Vide Chr. Table I.

PRAMAT'HI, (ప్రమాది) — The 13th of the same.

PRA'NA'CA'LA, (ప్రాణశకా) — The 1-6th part of a *vicala*. See *Mārta*, and p. 5, 77, 104.

PRATHAMA, (ప్రథమ) — The first. — *Prathama tithi*, the first Tithi or Lunar day in the month; that which always follows the day of last conjunction; vide p. 70, 79, 109, 112, 137, 172, 229. — *Prathama chara*, Ascensional difference of the 1st Sign of the Hindu Tropical Zodiac; vide p. 103. — The same for the Sun's declination and Amplitude; vide p. 102, 103. — *Prathama jiva*; the Sine of the first *Pinda*. Vide p. 39 of the Tables.

PRITI, (ప్రితి)—The Foga of the 2d Lunar mansion, supposed 35 *Arietis*. Vide p. 74.

PUNARVASU, (పునర్వసు)—The 7th Lunar mansion. Vide p. 74.

PANCHAMI, (పంచమి)—The 5th Lunar day of the month. Vide p. 70.

* PURANAS, (పురాణం)—Books held in high veneration by the Hindus, treating of Theology, Literature and Astronomy, and other matters, of which there are 18 principal ones: they take these productions, as usual, to be of the highest antiquity; but modern European commentators have been very active and industrious in their endeavours to bring down the epochs of their respective compositions nearer to our times. Many of the Puranas are now believed to be very recent, and one of them in particular is conjectured not to be above 100 years old.

PURNIMA, (పుర్ణిమ)—Opposition (sometimes written *Purnimā*).—*Purnima tithi*, the day of opposition or full Moon. Vide p. 67, 70, 313, 320, 339.

PURVA, (పుర్వ)—When referred to one of the Lunar mansions means the FIRST, and in the same manner as *Uttara*, means the SECOND. Vide p. 74.

PURU, (పరు)—The East point of the compass.

PUSHYA, (పుష్య)—The 8th Lunar mansion, vide p. 74, where the word is sometimes wrongly spelt *Pushia*.

R.

RA'C'SHASA, (రాక్షస)—The 49th year of Jupiter's cycle. Vide Chr. Table F.

RACTACSHA, (రక్తక్షి)—The 38th of the same.

RAGINIS, (రాగిని)—Spirits, or demi-goddesses personifying the notes of music.

RA'HU, (రాహు)—The Moon's ascending Node.—In a physical sense the Hindus consider it as one of the obscure Planets, which occasion Eclipses: but according to mythology, *Ra'hu* is the head of a monster, of which *Cetu* (the descending Node, spelt *Ketu* in the Text) is the trunk.—It is supposed by some commentators to be the *Typhæus* of Hesiod. Vide the war of the *Sûras* and *Asûras* in the *Mahābhārata*, also p. 77, 308, 310, 310.

RA'MA', (రామ)—The principal of the *Avatāras*, or descents of *Vishnu*: a great conqueror, and the Prince whose reign forms the most important epoch of Indian history.—Sir William Jones places the subjugation of India by *Ra'ma'* about the year 1810 before Christ. Mr. Bentley, after a much more accurate research, fixes his birth on the 6th April of the year 961 before Christ: In his time and that of his father *Das'aratha*, Astronomy was much cultivated; and it is supposed (not without much probability) that the first Astronomical Tables for computing the places of the Planets were constructed on the observations made in *Ra'ma's* time. There was an Eclipse of the Sun on the 2d of July of the year 940 before Christ, which, according to Mr. Bentley, may be referred to with certainty, as an epoch of *Rāma's* reign.

RA'MA'YANA, (రామాయణ)—(of *Vālmīci*)—An historical poem, being one of the principal ones (*viz.*

Indians) with those that *Timocharis* had made at Alexandria about a century before, and perceived by the results, that the Stars appeared to have advanced (though slowly) from West to East, relatively to the Equinoctial points, he was far from imagining that Indian Astronomers (perhaps several centuries before his time, and in all probability by observations of the same Star) had already noticed the same variation, on which in after ages Sir Isaac Newton resolved and established the great problem of the Equinoctial precession.—The celebrated Indian Astronomer *Arjya bhatta*, probably puzzled how to account for the change of the position of the line of the *Rishis* which, he admitted, had intersected the middle of the moveable Lunar mansion *Magha* in the year of the *Caligug* 1910, and which he pretended to cut (when he wrote) the beginning of *Aswini*, imagined a curious system on the seven Stars of the Great Bear, to which he supposed a proper motion to the Eastward, at the rate of $15^{\circ} 20'$ (a Lunar mansion) in 100 years; which amounted to 159999 revolutions in a *Calpa*, and which squared his account. But this absurd doctrine has long since been abandoned by all manner of Indian Astronomers; many of whom, now in existence, have never heard of it.—The term *Rishi* is also applied (in a sense totally different) to the *Fan'uprastha* Brahmins, or inhabitants of the desert. Of these the most ancient and celebrated were the seven great *Rishis* or penitents, who had retired in the territory washed by the Indus; and it was to them, it is supposed, that Alexander the great applied for instruction after invading their country. Vide p. 83, 243.

RĪTU, (ఋతు)—A season, of which there are six of two months each in the Solar year, (vide *Varanta*, *Grithma*, *Varaha*, *Sarada*, *Hemanta* and *Sistra*.) Vide p. 4.

RO'HINI, (రోహిణి)—The 4th Lunar mansion. Vide p. 74.

ROHITACA, (రోహితక)—A mountain or place lying under the Meridian of *Lauca*.

ROMACA, (రోమక)—One of the four imaginary cities lying under the Equator. Vide *Lauca*.

RUDIRO'DGARI, (రుద్రోద్గారి)—The 37th year of *Jupiter's* cycle. Vide Chr. Table I.

RUDRA SAVARNI, (రుద్ర సావర్ణి)—(The same explanation as for *Rauchya*.) Vide p. 311.

RUG, RUC, or RIG VEDA, (ఋగ్వేద, ఋగ్వేదక)—The first of the inspired Vedas. *Rig*, signifying the science of divination, of which it principally treats. It also teaches Astronomy, Astrology, Natural Philosophy, and gives a particular account of the formation of matter, and the creation of the world.

RU'PA, (రూప)—An entire number.

S

SA'CA, (శక)—An epithet given to a Prince to whose name posterity refers an *Era*. (Vide *Salivahana*).

SA'CHA, (శాఖ)—Department; branch of knowledge.

SADHA'RANA, (సాధారణ)—The 44th year of *Jupiter's* cycle. Vide Chr. Table I.

SA'DHYA, (సాధ్య)—The Vega Star of the 22d Lunar mansion, α *Aquila*, Vide p. 74.

- S'A'LIVA'HANA, (కాశీవాహన) —The name of a Prince who is said to have reigned in a country called *Magadha*.—He instituted, or was the cause of the institution of an *Æra*, which bears his name, the beginning of which is referred to the epoch of his birth. This event is supposed to have taken place when 3179 years of the *Calî-yug* had expired, which makes it fall 78 years after the beginning of the Christian *Æra*.—The *Saca* year is the same as, and begins with, the common Solar year. Vide p. 18, 203, 222, 223, 225, 230, 302, 303, and of Chr. Table p. 31, Table I.
- S'A'LMALA, (కాల్మల) —An island lying East of *Lanka*, supposed to be *Ceylon*.
- SAMA AND VISHAMA, (సమ, విషమ) —Literally *even* and *odd* (vide *Paridhi*, and *Paridhi anu*).—*Sama mād'ala ch'hāṣṣṭ*, the Shadow of a Gnomon when the Sun is East or West of it. Vide p. 97.
- SAMA'GAMA, (సమాగమ) —The occultation of a Star.
- SAMARGA, (సమార్గ) —A term used in the Kalendar to denote a middle state of abundance; neither favourable nor unfavourable to the productions of the Earth. Vide p. 312, 313.
- SAMVATSARA, (సంవత్సర) —A year: chiefly applied to the Luni-solar year. Vide *Mausi*; also p. 71, 77, 155.
- SA'MA VE'DA, (సామ వేద) —The 3d of the inspired *Vedas*. This book treats of all religious and moral duties: It also contains many hymns in praise of the Supreme Being, as well as verse in honor of the gods.
- SANCRA'NTI, (సంక్రాంతి) —The day on which the Sun enters a new Sign of the *Ecliptic*.
- SA'NCU, (శంకు) —A Gnomon for Astronomical purposes. The Pillars which are erected in front of every Pagoda are real Gnomons. Vide p. 91, 92, and Table XXXIV.
- SANDHI, or SANDHYA, (సంధి, సంధ్యా) —The Twilight or Crepuscule. The Sandhy of Brahma consists of 1728000 Solar Sydereal years; the same duration as the *Crita*, or *Satya-yug*, which quantity is used in its double capacity for constructing the *Calpa*.—*Prāṭas sandhya*, the morning twilight.—*Sāyam sandhya*, the evening do.—N. B. The twilight of each *yug* is equal to 1.6th part of the same. Vide p. 78.
- SANCHYA' GAN'ITA, (సంఖ్యాగణిత) —Algebra (vide *Katapayadi*).
- SANGAMA, (సంగమ) —Conjunction. (Vide *Arcāṇa sangama*.)
- SANHITA, (సంహిత) —A treatise on any branch of Knowledge.
- SANI, (శని) —A name of *Saturn*: the most common of all; vide p. 6, 189.—*Sani-vara*, Saturday.
- SANIHITA SARAH, (సంహితాసార) —One of the ancient cities which are stated in books on Hindu astronomy, to lie under the same meridian with *Lanka* and *Ujant*. Vide p. 9.
- S'ARADA, (శరద) —The 4th season, comprehending the months of *Āshvina* and *Carticay*, when the Sun is in the Signs *Canya* ♎ and *Tula* ♎; answering to the Tamil months *Purattasi* and *Āṣvini*. Vide p. 4.
- SARVADHARI, (సర్వధారి) —The 22d year of Jupiter's cycle. Vide Chr. Table I.

- SHUSTI, (𑖦𑖳𑖫𑖮)—The 6th Lunar day of the *Pachā*. Vide p. 70.
- SIDDHA, (𑖦𑖳𑖫𑖮)—The *Yoga* Star of the 21st Lunar mansion. Uncertain; perhaps ☿ *Sagittarii*. Vide p. 74.
- SIDDHI (or ASRIJ) (𑖦𑖳𑖫𑖮)—The *Yoga* Star of the 16th Lunar mansion; perhaps 21 *Lihra*. Vide p. 74.
- SIDDHANTA, (𑖦𑖳𑖫𑖮𑖫𑖮)—literally signifying *Demonstrated, established truth*; also a *conclusion*. In Astro-nomy; a treatise on that science. There is a numerous train of treatises of this kind, of which four only are reputed to be of divine origin, viz.: 1^o The *Surya*; 2^o The *Brahma*; 3^o The *Paulastya*; 4^o The *Soma Siddhantas*.—*Parāsūra*; *Varāha*, and his son; *Bhāscara* and others have left *Siddhāntas* and *Tikas*, which are now in repute. But doubts have arisen whether the *Parāsūra Siddhanta* which exists, be a legitimate or spurious production. Mr. Bentley decides for the latter and believes it to have been forged by *Ārya Bhātta*.
- SIDDHAPURY, (𑖦𑖳𑖫𑖮𑖫𑖮)—One of the imaginary cities which are supposed to lie under the Equator at 30° from each other. (Vide *Laoca*).
- SIDHARTI, (𑖦𑖳𑖫𑖮𑖫𑖮)—The 53d year of *Jupiter's* cycle. Vide Chr. Table I.
- SIGHRA, (𑖦𑖳𑖫𑖮)—Answering to what European Astronomers call *Parallax*; (vide *Chaturtha p'hala*, and *Virdhamunda p'hala*).—*Sighra chaturtha*, the same as the last.
- SINHA, (𑖦𑖳𑖫𑖮)—The Hindu Solar Sign *Leo* ♌.
- SISIRA, (𑖦𑖳𑖫𑖮)—The 6th season of the year, comprehending the Hindu Solar months *Māgha* and *Phalguna*, when the Sun is in the Signs *Macara* ♊, and *Camb'ha* ♋, answering to the Tamil months *Tye* and *Maussi*.
- SITTANDIJ, (𑖦𑖳𑖫𑖮𑖫𑖮)—A term used by Father Beschi to designate a certain sect of Astronomers who reside in the Southern parts of the Peninsula. It is unknown to the Madras Pandits.
- SIYA, (𑖦𑖳𑖫𑖮)—The third person of the Hindu triad, and the principal personification of time. The forms and names which this godhead assumes are without end, and therefore shall be passed over.—*Siva* is also the *Yoga* Star of the 20th Lunar mansion and supposed to be the same as ☿ *Sagittarii*. Vide p. 74.
- S'LOCA, (𑖦𑖳𑖫𑖮)—A verse: a memorial couplet; also a technical rule for computing certain astronomical problems, delivered in verse in the *Surya Siddhanta*.
- SOBHANA, (𑖦𑖳𑖫𑖮)—The *Yoga* Star of the 5th Lunar mansion. Very uncertain; but may be 113, 116, or 117 *Tauri*; vide p. 74.—*Sōbhana* means also the 27th year of *Jupiter's* cycle. Vide Chr. Table I.
- SOBHVA, (𑖦𑖳𑖫𑖮)—called SOBHACRITU in the Carnatic, (𑖦𑖳𑖫𑖮𑖫𑖮)—(wrongly written *Soobhyam* in the Text)—A constant number to be subtracted in certain computations, to fit the rule to a particular epoch, being the negative of *Cshēpa*, which see. Vide p. 54, 65, 81, 110, 240.
- SOMA, (𑖦𑖳𑖫𑖮)—A name of the Moon.—*Soma vara*, Monday. Vide p. 6.
- SPHUTA, (𑖦𑖳𑖫𑖮)—(wrongly spelt in the Text *Sputa*).—True, or apparent; in contradistinction of *Madhyama*,

or moon.—*Sphuta rasi*, or *Chandra graha*, or *gati*, true or apparent place or motion of the Sun and Moon, in the Sydercal Zodiac. Vide the whole context of the second Memoir.

SPRIG, or SPRIGH, (స్ప్రిగ్) (wrongly written in the Text *Sprohu* or *Sprahoo*)—A Lunar intercalary day repeated during two successive Solar days in the Kalender.

SRAVANA, (శ్రావణ) —The fourth month of the Hindu Solar year, when the Sun is in the Sign *Cancer* ♋, answering to the Tamil *Audi*; vide p. 5, and Table III.—Also the 5th month of the Lunar solar year, owing to that sort of year beginning with *Chaitra*; vide p. 69.—*Śrāvana*, the 22d Lunar mansion. Vide p. 71.

SRI, (శ్రీ) —The *Venus* *Aphrodite* of the *Indians*, born like the *Grecian Venus* from the Sea. (See *Lacshmi*, and *Crishna*).—*Sri-Crishna* is the 9th, and *Sri-Rama* the 7th incarnations of *Vishnu*, as a *Cabotia*; and a *Dwarf Brahmin*, the anniversaries of which are observed. Vide p. 311.

SRI'MUCHA, (శ్రీమూచ) —The 7th year of *Jupiter's* cycle. Vide Chr. Table I.

SRISTYADI DIGONA, (స్రీస్త్యదిగొన) —(spelt *Sirostidi Digona* in the Text.)—The number of natural days expired from the grand astronomical epoch when the Planetary motions are supposed to have first commenced, to any other epoch for which their places are to be computed. Vide p. 70, 80, 81, 82, 243.

STHITYAR'DHA, (స్థితిర్ధ) —The time from the beginning of an Eclipse to its middle.

STHIRA, (స్థిర) —A general term for the 4 extraordinary *Caranas*. Vide *Carana*, and p. 75.

STHULA, (స్థూల) —(Vide *Marta*.)

SUBHA, (సుభ) —The *Yoga* Star of the 23d Lunar mansion, α *Delphial*. Vide p. 74.

SUBHACRIT, (సుభక్ర) —The 36th year of *Jupiter's* cycle. Vide Chr. Table I.

SUBHANU, (సుభాను) —The 17th of the same.

SUCARMA, (సుకర్మ) —The *Yoga* Star of the 7th Lunar mansion, β *Geminorum*. Vide p. 74.

S'UCLA, or SUDHA, (సుక్ల, సుద్ధ) —The 1st or enlightened half of the Lunar month.—The 3d year of *Jupiter's* cycle. Vide Chr. Table I.

SU'CBI, (సుచి) —The Earth's disc in computing Eclipses.—The fourth term of a proportion, which is to the Moon's equated motion, as the diameter of the Earth, is to her mean motion. This proportion serves in the computation of Lunar Eclipses, to adapt the Earth's shadow, to the Moon's distance and apparent diameter.

SUCRA, (సుక్ర) —One of the names of the Planet *Venus*.—*S'ucra-vara*, Friday.—*S'atra* or *Subra*, the *Yoga* Star of the 24th Lunar mansion, perhaps λ *Aquarii*. Vide p. 74 and Table XLIV.

S'UDDHA COTI, (సుద్ధకోటి) —One of the sides of a right angled Triangle; the second being sometimes called *Bhaja*, and the hypotenuse *Carna*. Vide p. 91, 94.

S'UDDHA DINA, (సుద్ధదిన) — (wrongly spelt *Soota dina* in the Text) — The day on which a particular phenomenon is to occur. Vide p. 8, 79, 81, 83, 243, 244, and Tables XLVIII and XLIX.

SU'LA, (శూల) — The Yoga Star of the fifth Lunar mansion. Uncertain; perhaps 49 or 50 *Cancer*. Vide p. 74.

SUMERU, (సుమేరు) — The Northern hemisphere. — A fabulous region over the North Pole, where *Indra* is said to preside over the *Sásas* or *Devatas*. (Vide *Cumêru*).

SUNYARGA, (సూన్యార్గ) — A term meaning *scarcely*; or a time unfavourable for agricultural undertakings, which occurrence is, from time to time, predicted in the *Kaletar*. Vide p. 312.

SUPTAMI, (సప్తమి) — The 7th day of the Lunar *Pocsha*. Vide p. 70.

SURA, (సుర) — A measure of time equal to the 1-60th part of a *para*, which see. Vide also p. 6.

SURABHI, (సురభి) — The mythological Cow that grants every boon in allusion to the Spring.

SURA DEVI, (సురదేవి) — The goddess of wine; sometimes used figuratively to signify the year.

SURAS, (సరాస) — Benign spirits governed by *Indra*, harbouring about the North Pole, who with the *Asuras* churned the ocean, and extracted the *Amrita* or water of immortality, pending which a furious war broke out among them, in which *Vishnu* took a part, as well as *Surya* and *Chandra*, who were the occasion that *Rahu's* head was severed from its trunk by the irresistible operation of *Vishnu's* *chakra*; all which allegories figure an Eclipse of the Sun, which occurred near the Moon's ascending Node. (Vide *Devatas* and *Asuras*).

SURYA, (సూర్య) — The name most generally given to the Sun (vide *Ravi*). — *Surya savant*, one of the 14 Patriarchs who preside successively over the 14 *Manvantaras* of the *Calpa*. Vide p. 311.

SURYA SIDDHANTA, (సూర్యసిద్ధాంత) — The first (though not the oldest) of the authentic and inspired *Sastras*, held in great veneration by all manner of Hindu Astronomers, although they acknowledge that its elements, without the assistance and use of the *likas*, or commentaries, no longer furnish means for representing the true positions of the Planets. It is pretended that this book was revealed 1000 years before the beginning of the *Treta yug* (A. 3027401—Ante Christum). — European commentators, however, have all agreed to reduce considerably this enormous antiquity, though they still differ vastly in their opinions touching its true epoch; some supposing it to have been written 2050 years before Christ (i. e. 98 years after the Flood), others in the 1268th year of the Christian *Æra*. Mr. Bentley, however, seems to have proved, after a very profound research, that let the antiquity of the *Surya siddhanta* be what it may, it only came into general use in A. D. 538. — Vide the whole of the second Memoir of the *Kala Sankalita*, and particularly p. 7, 17, 63, 69, 90, 199, 200, 239, 246, 325, 329, and Tables XVII, XLVIII and XLIX.

SU'TRA, (సూత్ర) — A rule, a precept, a computation.

SWARO'CHISHA, (స్వరోచిష) — One of the 14 Patriarchs who preside over the 14 *Manvantaras* of the *Calpa*, noticed in the *Kalendar*. Vide p. 311.

SWATI, (स्वाति) —The 15th Lunar mansion. Vide p. 74.

SWAYAMBHUBA, (स्वयम्भुव) —One of the Patriarchs as stated, article *Swārochishā*. Vide p. 311.

T

TADYA, (तद्य) —The 3d Lunar day of the *Pancha*. Vide p. 70.

TAMASA, (तमस) —One of the 14 Patriarchs (vide article *Swārochishā*).

TAMIL, (தமிழ்) —The name of a language, and of an extent of country where that idiom is in general use (spelt *Tamul* in the Treat), and for which the *Solar Kalendar* (*Rasi Panchanga*) is computed. Several European writers, and particularly Missionaries, speak frequently in their books of the land of *Tamil*, as if it were delineated upon the Map of India, like the territory of a particular state; but I am perfectly satisfied that none of them entertained any distinct idea of the country they were speaking of. The obscurity into which this designation is involved, has induced me to make some researches of the probable position and extent of the land under consideration; and what follows is an abstract of my information.^(*) —“The *Tamil* land is the same with *Dravira*, and comprehends all the districts in which that language is spoken, enclosing a portion of the Eastern parts of the Peninsula.” —“When *Dravira* was confined to the *Chola Pandya*, and *Chera* principalities, its Northern boundary was the *Pal-nur* river. When the Chola-Princes colonized *Tondamandala*, it was extended Westward to *Tripetti*, in a line with *Pallat*, at which some pretend that the land of *Dravira* was met by that of *Tellingana*. Other authorities however, extend it to the North, up to the river *Christna*; and the latter supposition agrees best with our modern notions of the Geography of the country.” But if we attempt to estimate the extent of the land of *Tamil* by that through which the language of that name is spoken, we fall into the region of conjectures, some of which, however, may be grounded on what follows: “The Indian dialects which originated in Sanscrit, are said to be ten; viz. 1^o The sacred language used by the Priests and *Bhaddists* in the Island of Ceylon. 2^o The *Tamulic*, spoken in the Deccan and some parts of the Malabar Coast. 3^o The *Malabar*, extending from Cape Comorin (Comorin) to Mount *Illu* (Dilly), which separates Malabar from Canara. 4^o The *Canarian*, used in the districts of *Illu* and thence to *Gou*. 5^o The *Marattah*, spoken by the various nations of that republic. 6^o The *Teluga*, [Tellinga] used on the Coast of Oriza, and in *Solconda* (the Nizam’s territory), down to the river *Christna*. 7^o The *Bengalic*, spoken in the province of Bengal. 8^o The *Hindustanee*, which is principally used in the upper provinces of the Bengal Presidency, but known throughout India, where it has become an intermediate means of communication between people speaking different languages. 9^o The *Guzuratic*, introduced into *Guzarat*, *Baroach*, *Serat*, *Tatto*, &c. 10^o The *Nepalic*, of which eight dialects are spoken in *Nepal*.” —What is stated in the second article of this enumeration, agrees well enough with the former Geographical description. We may therefore

(*) These particulars were obligingly communicated to me by Dr. Wilson of Calcutta, and Captain D. Monquenerie, Deputy Secretary General in India.

is the tithi on which the conjunction falls.—The 15th tithi (also called *Pavarnamī*) is distinguished by the name of *Pārnimā*, meaning that it is the day of opposition. Vide p. 60, 70, 72, 76, 90, 109, 112, 117, 164, 172, 307, and of Chr. Tables p. xvii and Table II.

TITHI TATWA, (திதிதத்து)—A particular Kalendar which marks all the fasts, religious observances, and ceremonies prescribed on certain days of the year.

TRAYO'DASI, (த్రையோட்சி)—The 13th Lunar day of the *Pauṣa*. Vide p. 70.

TRETA YUG, (தேவையுகம்)—The 3d period of a *Mahā yug* used in the construction of the *Calpa*; the Hindu silver age, consisting of 1296000 Solar Syderal years. Vide p. 7, 77.

TRIDI SPRIC, (திரிதிஸ்ப்ரிகம்)—(wrongly written in the Text *Tridina sprohoo*)—Vide articles *Spric* and *Athica*.

TRIJYA, (திரிஜ்யா)—A term answering to *Radius*, being the Sine of 3 Signs or 90°. Vide p. 101, also *Danjya*, p. 23.

TRIN, or **TRAIRA'S'ICA**, (திரைசிகா)—A rule of proportion.—The common rule of three; constantly used in the resolution of Problems of Hindu astronomy.—N. B. This rule is to be found in almost every article of the two first Memoirs.

TRICO'NA, (திரிகோணம்)—A Triangle.

TRIVALORE, (திருவால்வூர்)—A village in the Tanjore province, to which certain Astronomical Tables refer. According to the Hindu Geography, it lies 3° 32' 58" E. of Lanka in Longitude, and in 10° 44' N. Latitude. Vide Tables XXXIII and XXXIV.

TULA, (துலா)—The 7th Sign of the Hindu Syderal Zodiac, *Libra* ♎. Vide p. 5 and Table III.

TUNGA, **UCHA**, (துங்க, துச்சு)—Superior, higher.—*Tunga manda*, or *Manduchā*; the superior Apsis or Aphelion of a Planet. Vide p. 83, 84.

TYAJYA, (த்யாய்யா)—(wrongly spelt in the Text *Thyājum* and *Thyagum*)—That portion of a *Nacshatra*, which is deemed unlucky, is called *Varjya*, and the period of its duration is the *Tyājyā*.—It is called *Devī* when it occurs at day time; and *Ravi* when at night. It is therefore an astrological element: but is nevertheless registered every day in the Ephemerides; where the instant of its commencement is registered. Its mean duration is about 4 guddias (th 36th European time), so that the beginning being known, the end may be supported, with sufficient accuracy for practical purposes, without actual computation. Vide p. 75, 181, 307, also article *Varjya*.

TYE, (தீ)—The 10th Tamil Solar month, answering to the Hindu *Māghā*, when the Sun is in the Sign *Mācrā* ♌. Vide p. 5 and Table III.

V

* **VACIJ**, (வாகிஜம்)—Spelt in the Text *Vackij*, after Father Beschi's orthography.—This term, like that of *Sittandij*, is unknown to the Madras Pandits, but it is unquestionably used in the provinces of

Madura and Tinnivelly to designate a particular sect of Astronomers who reside in the Northern parts of the land of Tamil; vide p. 7 and Table I.

VAIDHRITI, (వైధ్రితి) — The *Yoga* Star of the 27th *Nakshatra* or Lunar mansion, ζ *Piscium*; vide p. 10, 74, 215.

VAISA'CHA, (వైశాఖ) — The first month of the Hindu Solar year, when the Sun is in the Sign *Mésha* γ , answering to the Tamil *Chitram*. Vide p. 5 and Table III.

VAJRA, (వజ్ర) — The *Yoga* Star of the 15th Lunar mansion, *Arcturus*. Vide p. 74.

VAKYAM, (వాక్యం) — (as written in the Text, but according to adopted system *Varyam*) — The Solar process for all manner of astronomical computations; vide the whole of the second part of the 2d *Mémoire*, from p. 118 to 148. — *Varyam dharmamāna*, an element of this process, being the remainder after division of the *Ahargana* by a *vedam*, *vara-gedica*, *chāḍāḷa* and *dēvaram*, which remainder, expressing a number of days expired of the current *dēvaram*, is the argument for using the first *cakram* table (the XXVth of this collection). Vide p. 10, 118, 122, 132, 133, 230, 330, and Tables XXVI, XXVII, XXVIII and XLVII.

VA'MANA', (వామన) — One of the incarnations of *Vishṇu* in the form of a *Brahmā Dwarf*; the anniversary of which is noticed in the *Kalendar*. Vide p. 311.

VANATA'NSA, (వనతాంశ) — (as spelt in the Text, but according to our orthography *Anantānsa*) — Altitude. — *Anantānsa bhāga*, degrees of altitude of an object above the horizon.

VA'RA, or **VASARA**, (వార, వాసర) — A week of seven natural days, named after the Planets and arranged in the same order as they are in the European week. The name of each day (beginning with Sunday, and adding *vara* to each) are, 1^o *Ravi*. 2^o *Sūra*. 3^o *Mungala*. 4^o *Budha*. 5^o *Guru*. 6^o *Sukra*. 7^o *Sēni*. — The tabular notation of the series, or days of the week is, 0 for Sunday, 1 for Monday, and so forth to 6 for Saturday; 7 being accounted zero. Vide p. 6.

VARA'HA, (వరాహ) — One of the incarnations of *Vishṇu*, in the form of a *Wild Hog*, the anniversary of which is noticed in the *Kalendar*; vide p. 311. — An Astronomer, the reputed author of a system of Astronomy referred to in the *Sūrya*, *Varāha*, and *Sāma Siddhāntas*, and therefore supposed by modern *Sāstris* to be anterior to them all. But European commentators entertain a belief that the work which goes by *Varāha's* name in present times, is not the real one; and that the treatise which has reached us, is a fabrication of no older date than the IXth century. — *Varāha Mihira*, another Astronomer, thought by many to have been cotemporary with the Emperor *Achut*; but whom others are apt to confound with *Varāha Acharya*, and others of the same name. — N. B. The *Telugu* Astronomers pretend that *Varāha Mihira* flourished in the 360th year of the *Call yug* (A. D. 409), i. e. at the close of the 2d *Padam* of the *Agamam*, when the Sun, Moon, and Equinoctial points (according to the doctrines of the *Sūrya Siddhānta*) were in

the first point of the Hindu Sydercal Zodiac ; or, in other words, when the *Rishis* were in the 1st point of the Solar Sign *Mesha* ♈, and in the same of the Lunar mansion *Aswini*.

YARGA, (𑖦𑖱𑖳𑖴)—See *Farga*.

VARIYA, (𑖦𑖱𑖳𑖴)—The *Yaga* Star of the 18th Lunar mansion, *Antares* ; vide p. 74.

VARJYA, (𑖦𑖱𑖳𑖴)—(wrongly spelt in the Text *Varjyam*)—A certain point in each *Nacshatra*, or Lunar mansion, called its *Dhruva*, determines the duration of this astrological element ; and the time which the Moon's disc takes to move across this ill-omened point, is called the *tyajya* ; the mean duration of which is about 4 ghadyas of time (1h 36' E. T.) ; but its true duration is greater or less according to the Moon's continuance in the incumbent *Nacshatra*, which depends on her position relatively to her *Apogee*, and determines whether her stay in the mansion be more or less than 60 ghadyas.—The *tyajya* of the *varjya* is always punctually registered in the Ephemerides of the Kalendar, of which it is one of the five permanent articles, by stating the time of its beginning. Pending its duration, all voluntary business of importance must remain suspended ; but as the instant of its ending is not announced in the Kalendar, people calculate generally on 4 ghadyas of inaction from the beginning of the *varjya*.

VARSHA, (𑖦𑖱𑖳𑖴)—The third season of the Hindu Solar year, comprehending the months of *Sravana* and *Bhadrapada*, when the Sun is in the Signs *Carcata* ♎ and *Simha* ♌, answering to the Tamil months *Audi* and *Auvani* ; vide p. 4.

VASANTA, (𑖦𑖱𑖳𑖴)—The first season of the year, comprehending the Solar months *Chaitra* and *Vaisaḥa*, when the Sun is in the Signs *Mina* ♈ and *Mesha* ♈, answering to the Tamil months *Pungoni* and *Chitram* ; vide p. 4.

VAVILALA CUCHINNA, (𑖦𑖱𑖳𑖴)—A Telugu Astronomer who is supposed to have flourished in the 4390th year of the *Calī yug*. He has left some tables for computing the position of the Planets, and some tracts on the construction of the Lank-solar Kalendar, of which the Appendix to the second Memoir of this collection is one. These are much esteemed by the Astronomers in *Telingana*. Vavilala's computations refer to the meridian of *Lanka*, and agree better with the doctrines of the *Surya Siddhanta* than those of any of his compatriots ; vide p. 81, 153, 167, the Appendix to the 2d Memoir, and the Tables from XLI to XLV.

VAYU, (𑖦𑖱𑖳𑖴)—The Atmosphere.

VEDAM, (𑖦𑖱𑖳𑖴)—An element of the *vayam*, or Solar process ; containing 1600834 days ; vide part 2, second Memoir, and p. 122, 132, 133, 335.

VE-DAS, (𑖦𑖱𑖳𑖴)—The inspired books, four in number, viz. 1^o The *Rig* ; 2^o The *Sāma* ; 3^o The *Yajur* ; 4^o The *Atharvama vedas*. (For the particulars of each, see the respective terms).

VEDHEI, or **YETHEI**, (𑖦𑖱𑖳𑖴)—An astrological element, an account of which is given at pages 76, 305 and 309 of the Text, and noticed in all the Ephemerides.

- VELLI, (వెల్లి) — The Tamil name of *Venus*.
- VLARCENDU SANGAMA, (వలరేంద్ర-సంగమ) — (wrongly spelt in the Text *Flarea-Iadu-Sangama*) — Conjunction of the Sun and Moon. Vide p. 70, 89, 90; also *Arçēnda Sangama*.
- VLASSEI, (వైయ్యసే) — The 2d Solar Tamil month, answering to the Hindu *Jaiśv'ra*, when the Sun is in the Sign *Vriśha* ౪; vide p. 5 and Table III.
- VIBHAVA, (విభవ) — The 2d year of Jupiter's cycle; vide Chr. Table I.
- VICALA, (వికలా) — The 1.60th part of a *cāla*. The second of π degree.
- VIGARI, (వికారి) — The 33d year of the cycle of Jupiter; vide Chr. Table I.
- VICRAMA, (విక్రమ) — The 14th year of the same.
- VICRAMA'DITYA, (విక్రమ-దిత్య) — A Prince who has given his name to an Era, and who is said to have flourished 135 years before *Sālivāhana*. Its epoch falls when 3044 years of the Cali yug had expired. The Era *Vicramāditya* is little used in the Peninsula of India, although its current year be generally inserted at the head of the Kalendars. — In those provinces where it is current, it serves to number the Luni-solar years, in the same manner as the Era *Sālivāhana* in the Coromandel for the Solar ones; vide p. 18, 203, 295, 302, 303, 313, 318; and of the Chr. Tables p. xii, and Table II.
- VICRITA, (విక్రీతి) — The 24th year of Jupiter's cycle; vide Chr. Table I.
- VICSHEPA, (విక్షేప) — Celestial Latitude (vide *Patana*). — *Vicshepa Dhruva*, the greatest inclination of a Planet's orbit; vide *Parāma'pama* and p. 74, 91, 342. — *Vicshepa putaca cala*. See Tablest p. 342.
- VIDIYA, or DWITYA, (విదీయా, ద్వీతియా) — The second Lunar day of the *Pursha*; vide p. 70, 112.
- VIGHAD'IYA, (విఘడియా) — (spelt in the Text *vighadīo*) — The 1.60th part of a *ghadiga*; an Indian minute, equal to 24 seconds European time.
- VIJAYA, or VIJYA, (విజయ) — The 27th year of Jupiter's cycle; vide Chr. Table I.
- VILAMVA, or VILEMBI, (విలంబి) — The 32d of the same.
- VILIPTA, (విలీప్త) — See *Vicāta* and *Mārta*.
- VIMARDHARDHA, (విమరదహర్దహ) — The time from the apparent conjunction to the end of an Eclipse. (Vide *Sihityardha*).
- VINADICAY, (వివాదిక) — The 1.60th part of a *nashicay*; vide p. 5, 71.
- VIPALA, (విపలా) — The same as a *pranata'la*, the 1.6th part of a *pala*; vide p. 5.
- VIRDHAMANDA PHALA, (వృద్ధమండఫల) — The equation of the second inequality in the motion of the inferior Planets. (Vide *Sighra* and *Sighra Chaturtha*).
- VIRO'DHACRIT, (విరోధాకృతి) — The 45th year of Jupiter's cycle; vide Chr. Table I.
- VIRO'DHI, (విరోధి) — The 23d of the same; vide do.
- VISA'CHA, (విశాఖ) — The 16th Lunar mansion; vide p. 74.
- VISHAMA, (విషమ) — A Planet is said to be in *vishama* when it is in 90° from the *Apsides*. — The Sun is in

śhama, when he is in the Equinoctial points.—*Vishama śhāyā*, the Shadow of the Gnomon at midday when the Sun is in the Equinoxes, (vide *Palāḥa*).—*Vishama tarna*, the hypotenuse of a right angled triangle formed by the *Sanea* (Gnomon) and the two sides of the Shadow ; vide *Sana* and *Paridhi*, also p. 91, 94.

VISHUCAMBHA, (విశ్వంభ) —The *Yoga* Star of the 1st Lunar mansion ; supposed to be γ or β *Arctis* ; vide p. 74.

VISHU, (విశు) —The Tamil name for the 15th year of *Jupiter's* cycle,—the same as *Eriga*.

VISHNU, (విష్ణు) —The second person of the Hindu triad,—the preserving power, too well known to be further particularized.—*Vishṇu* is often taken as a personification of time, as well as *Siva* ; vide p. 311, —*Vishṇu śāstram*, a treatise on astronomy.

VISHUVA, (విశువ) —The Equinoctial points, called also *Ayanas*, *Dhruvas*, and *Crauti*. *Padar*.—*Vishuvā dina*, the day of the Equinoxes.—*Vishuvā śhāyā*, the Shadow of the Gnomon at noon on those days ; vide *Vishama*, and p. 84, 313.

VISHVAVASU, (విశ్వవసు) —The 39th year of *Jupiter's* cycle ; vide Chr. Table I.

VISTI, (విష్టి) —(spelt *Vasti* in the Text.)—A name for the 7th and ordinary *Varana*, also called *Bhadra* ; vide p. 72.

VRIDDHI, (వృద్ధి) —The *Yoga* Star of the 11th Lunar mansion ; very uncertain ; perhaps 70 or 71 *Leonis* ; vide p. 74.

VRIDDHYARGHA, (వృద్ధ్యర్ఘ) —A term used in the Calendar to signify *Abundance* ; *Plenty*.—It also means the time favourable for agricultural operations (*astrological*) ; vide p. 312.

VRĪHASPATI, or **VARAĀSPATI**, (వృహస్పతి) —One of the most common names of the Planet *Jupiter*.—*Vṛihaspati chakra*, the cycle of 60 years which gives a specific name to all the Solar and Lunar solar years.—*Vṛihaspati nimā*, the year of *Jupiter*, during which he describes one sign of his orbit.—N. B. The *Telugu* Astronomers make no difference between this and the common Solar year ; vide p. 70, 147, 185, 212, 226, 303, and the Tables from XI to XIX ; also Chr. Table I.

VRISHA, (వృష) —The Solar Sign *Taurus* τ ; vide p. 5 and Table III.

VRISCHICA, (వృశ్చిక) —The Hindu Solar Sign *Scorpio* σ ; vide do.

VRITHAM, (వ్రతం) —Fast, or day of fasting ; vide p. 311.

VURGA, (వర్గ) —(so spelt in the Text, but perhaps more correctly *Varga*.)—The square of a number.—*Varga mūla* or *meta*, the square root of the same ; vide p. 313.

VYAYA, (వ్యయ) —The 20th year of *Jupiter's* cycle ; vide Chr. Table I.

VYANGHATA, (వ్యాఘాత) —The *Yoga* Star of the 13th Lunar mansion ; uncertain ; perhaps 7 or 8 *Corvi*.

VYANGULA, (వ్యాంగుల) —The 1-60th part of an *angula*, or digit (wrongly spelt in the Text *vinculo*).—A measure used in the computation of Eclipses, and *Gnomonic* Problems.

VYASAM, **VISHUCAMBHAM**, **VISTRITI**, (వ్యాసం) —Terms used to express the diameter of a circle,

VYATIPATA, (వ్యతిపాత) —The *Yuga* Star of the 17th Lunar mansion, ౩ *Scorpii*. Vide p. 74.

VYWASWATA, (వైవస్వత) —One of the 14 Patriarchs who preside successively over the 14 *Manvantaras* of the *Calpa*. Vide p. 311.

U

UCHA, (ఉచ్చ) —The *Apoes* of a Planet's orbit. (Vide *Mandecha*.)

UJANI, (ఉజ్జయిని) —(wrongly spelt in the Text *Ujjayini*) —A city under the same meridian as *Lanka*; supposed to lie near the modern town of *Oogéin*. Its Longitude from Greenwich, is therefore 75° 39' 10" E. Its Latitude is 23° 11' 30" North. Vide p. 9.

ULLAGNA, (ఉల్లగ్న) —The *Lagna* of a particular place; answering to the oblique ascension of the asters, in any place which has Latitude; vide p. 92, 101, 103, 104, where the *Ullagna* of *Madras* is given for every Sign of the Zodiac; and Table XLVI, for the Latitude of 16° 15'.

UPHA'DI, (ఉపాధి) —(wrongly spelt in the Text *Opadi*) —A term referring to the Luni-solar Kalendar, and meaning an expunged day. Vide *Tithi*; also p. 72, 311.

UTPATA, (ఉత్పాత) —Some natural prodigy or phenomenon.

UTTAMA, (ఉత్తమ) —One of the 14 Patriarchs who preside successively over the 14 *Manvantaras* of the *Calpa*. Vide p. 311.

UTTARA, (ఉత్తర) —(wrongly spelt *Futra* in the Text) —The North point. —When *Uttara* is prefixed to the name of a *Nacshatra*, it means the second of the same name. (Vide *Purva*.)

UTTARA JYA, (ఉత్తరజ్యా) —The versed Sine of an Arc. Vide Table XXX.

W

WARNIJA, (వర్ణిజ) —(spelt in the Text *Warnaji*) —The 6th and ordinary *Carana*. Vide p. 75.

WURJUM, (వర్జ్యం) —See *Furjya*.

WUTRAJYA, (ఉత్తరజ్యా) —An element of Hindu Spherical Trigonometry. Vide p. 99, and for the demonstration p. 42 of the Tables.

Y

YAJUR YE'DA, (యజుర్వేద) —The second of the inspired *vēdas*, which comprehends the whole science of religious rites and ceremonies, such as fasts, festivals, purifications and sacrifices.

YAMA, (యమ) —The godhead who presides over the *Anúras* or *Duties*. (Vide *Devatas*.)

YAVA COTI, (యవకోటి) —One of the four imaginary cities supposed to lie under the Equator at a distance of 90° from each other, *Yava-coti* being West of *Lanka*. Vide p. 9.

YECADASI, (యేకాదశి) —The 11th Lunar day of the *Pacsha*. Vide p. 70.

YOJANA, (योजन)—An Astronomical and Geographical measure, deduced from the ratio of the diameter of the Earth to the circumference of its Equatorial circle. The dimensions of the *yôjana*, like those of any other measure, originate in an arbitrary division of extent, for which the Hindus have chosen a finger or *angulâ*, as a standard to be found in nature. By that common measure they estimate not only distances, and the dimensions of the Earth, but even the distance of the Planets, their Parallaxes, and (when referred to particular points on the surface of the Earth) the effects of their Longitude and Latitude as to time. The Hindu Mathematicians divide the diameter of the Earth into 1600 parts, whence they have this expression $\sqrt{10 \times 1600} = 1264,9$ *yôjanas* for the value of the Equatorial circle. An angle of one minute of a degree is supposed to be subtended by 15 *yôjanas*, at the mean distance of the Moon; so that dividing the Earth's semi-diameter (800 *yôjanas*) by 15, we have $53' 20''$ for the Moon's mean horizontal parallax. It follows from this result that $33' 20''$ of the Moon's orbit will measure 15 *yôjanas*, and that her whole orbit ($360'$) will measure 324000 *yôjanas*. Hence 1059 (the circumference of a great circle of the Terrestrial Globe in *yôjanas*) is to 800 *yôjanas* (its semi-diameter), as 324000 (the circumference of the Moon's orbit in *yôjanas*) is to 51235 *yôjanas* her mean distance from the Earth: from which it follows that this distance (according to the estimates of Hindu Astronomers) is about 64 semi-diameters of the Earth.—As the Moon is supposed to complete 37753330000 Sydereal revolutions in a *Calpa*, this number drawn into 324000, gives 12712080854000000 *yôjanas* for her absolute motion during that time.—It is a principle in Hindu Astronomy “That the absolute motion of each Planet in a day, or any other given time, is equal to the absolute motion of the Moon in the same time.”—Hence if the absolute motion of the Moon during a *Calpa*, be divided by the number of mean revolutions completed by any Planet, during that period, it will give the *Circumference*, or circumference of the Planet's orbit in *yôjanas*.—To convert degrees of Latitude and Longitude into *yôjanas*, they use the following proportion: “As $360'$ to the proposed number of degrees; so 5059 *yôjanas* (the circumference of the Equatorial circle), to the number of *yôjanas* sought.”—The Hindus subdivide the *yôjana* into a great number of parts, in the following manner: The *yôjana* \div 4 *crossas* \div 1000 *dhanyush*, or *dandas* \div 4 *restas*, or *culits* \div 2 *tilistis*, or *spans* \div 2 *padas*, or foot breadths \div 6 *angulas*, or finger breadths \div 4 *paras*.—Some make the *crossa* = 2000 *dandas*, or half a *yôjana*, which agrees better with that in which the distances are usually computed. Vide Art. 8, Sect. I of the 1st Part of the 2d Memoir, p. 92, and the 2d Fragment, p. 330.

YECIYA, (येजिया)—(Vide *Duajya*, *Trifjya*).

YO'GA, (योग)—The leading or principal Star of a Lunar mansion, the position of which is given in the Hindu Astronomical Tables.—On these we shall only observe that in taking the Latitude and Longitude of Stars, as laid down in these catalogues, the former is to be considered as an arc of

the meridian which intersects the *Star* and the *Ecliptic*; and the latter as the portion of the *Ecliptic* which is intersected by the same meridian, and the Equinoctial *Colure*. There are 28 *Yoga Stars* (including *Abhijit*) in the Lunar Zodiac: but with the exception of 16 or 17 of these (on the identity of which there can be little doubt), it is very uncertain to which of the Stars in the European catalogues, the remainder corresponds.—*Harshana* (which no doubt is the same as our *Spica Virginis*) seems to be the *Yoga* which drew most the attention of the ancient Hindu Astronomers; probably on account of its convenient magnitude, and declination; which at the beginning of the 1Xth century was $9^{\circ} 38' 13''$ S.—To this Star they referred the beginning of the 7th month of their Solar Sydercal year, from which they concluded its beginning; and there is every reason to suppose that it was on the result of observations of *Harshana* that they established their *Granti-Pata-Gati*, or precessional variation; a surmise which, if correct, offers a singular concurrence of circumstances, for it was by observations of the same Star that *Hipparchus* first discovered (in the III century before Christ) the motion of the fixed Stars from West to East; vide p. 10, art. 2.—*Yōgu*, a term so pronounced by the Telugu Astronomers, and thus written in the Text, but *Yoga* as spelt by the Carnatic *Sautris*, is an astrological element, containing the same number of accidents as there are *Yogas* in the 27 regular mansions of the Lunar Zodiac; bearing the same names, and arranged in the same order; but having *no sort of Astronomical reference* to them.—A *Yogā* is the time during which the sum of the motions of the Sun and Moon, amounts to our *Nakshatra*, or $13^{\circ} 20'$. Its mean duration is $59^{\text{h}} 29^{\text{m}} 21^{\text{s}}$, 75 Indian time ($23^{\text{h}} 47^{\text{m}} 44^{\text{s}} 24^{\text{m}}$ European time); 17 of which are nearly equal to 16 days; which occasions an equation somewhat similar to that of the *Cahaya tithi* (which see). Vide p. 7, 10, 74, 77.

YOGHIADI PATACA, (యోగిదిపతకం)—The second Table of the *Yagya* process (the XXVIIIth of this collection), giving the equation of the Sun's motion, considered at the rate of 1 degree for a day, to his true motion for every 8th day in the year. Vide p. 124 and following.

YUDHISHTHIRA, (యుధిష్ఠిర)—A Prince of great celebrity in Hindu history, who according to Indian authors, reigned about the beginning of the *Cali yug*; some, however, fix the epoch of his reign 653 years later, or in the year 2448 before Christ. He is said to have been cotemporary with the Astronomers *Parásūra*, and *Garga*.

YUG, or YUGA, (యుగం)—Signifies properly the conjunction, and sometimes the opposition of the Planets. It is, however, more generally used for signifying a long period of years, at the expiration of which certain phenomena, or circumstances, recur.—The principal *Yugs* made use of in present times in Astronomical computations, have been mentioned and explained under the respective heads of *Mahayug*, *Satya*, *Treta*, *Dwapara*, and *Cali yug*, and need not be repeated in this article.—It is, we believe, generally admitted that ancient Astronomers invented their *Yugs* with reference to some of *Jupiter* and the Sun's conjunctions, in the beginning of the Zodiac; and

that more recent ones, (with a view to lengthen their periods), have referred them to those of *Saturn* and the *Sun*.—But modern European commentators have made such prodigious alterations in the epochs and durations of these *Yugs*, without changing their names, that we shall not attempt to follow them in a Glossary, which was only intended for facilitating the reading of the present work, and the study of modern Hindu Astronomy, with reference to that system of Chronology, which was followed in India since at least, *thirteen centuries*, an estimate which is by no means overrated, even if we adopt the opinions most unfavourable to the antiquity of the *Surya Siddhanta*; vide p. 7, 77.—*Yuga dina* (sometimes written *yugadia*) means the anniversary of the day on which the current *Maha yug*, and any one of the four lesser *Yugs* began; which anniversary is always noticed in the Kalender.—*Telugu* Astronomers use sometimes the term *Yugadia*, for *Aksharāna*. Vide p. 240, and Chr. Table II.

YURKA, or GURUJAH, (యూరక, గురుజ) —The 5th and ordinary *Carana*. Vide p. 75.

YUVA', (యూవ) —The 5th year of *Jupiter's* cycle. Vide Chr. Table I.

END OF THE GLOSSARY.

INDEX

Of Arabic, Persian, Hebraic, and Hindustanee words, and terms, used in the Kala Sankalita.—N. B. The orthography is that of the French Chronologers of the last century.

The languages are distinguished by A for Arabic, P for Persian, H for Hebraic, and Ind. for Hindustanee.

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On the Hindu Holy days and Festivals.

I SHALL offer but a few words on this subject, which has long since been laid before the public by Sir William Jones in his translation of *Raghunandana's* tract, containing an account of the rites and ceremonies observed generally by the Hindus during the course of the Luni-solar year. (*) My sole motive for enumerating these epochs anew, was to comply with the wishes of several Pundits with whom I had intercourse during the present research, and who conceived that my account of their various Kalendars would be incomplete if the present article were omitted.

I have compared the present list with that given in the *Tithi Tatva*; and with the only exception that the latter is much fuller, and consequently more satisfactory than the present one, I have found no material difference between them. The variations which occur are to be ascribed to local customs and circumstances; and therefore the present catalogue must be especially referred to the inhabitants of the Carnatic, although the same observances may be kept in other parts of India.

Of the fixed and moveable feasts.

These words are to be understood in their literal sense when referred to the respective Kalendars on which the festivals depend; but not so when these are compared, or referred to the European Kalendar.

Thus for instance the festival of *Srisâma-navamî*, always falls on the ninth Tithi of the first Pâsha, of the Lunar month Chaitra, and therefore, in as much as the *Chandra Panchangam* is considered, it is a *fixed* holy day. But it is clear that it must occur sooner or later every year, when referred to the *Ravi Panchangam*, according as the beginning of the Lunar falls nearer or farther from that of the Solar year.

The Hindus of the Carnatic observe 57 principal feasts during the course of the Luni-solar year; 32 of which are fixed, and 5 are moveable, in the sense above explained.

Besides these, there are five holy days governed by the Solar Kalendar: four of which are determined by the Epochs when the Sun is in the *Equinoctial* and *Solstitial* points of the *Sydercal* Elliptic. The fifth is only one of recreation. The natives of these Provinces observe, therefore, forty-two holy days in all.

Of the holy days which are governed by the Luni-solar Kalendar.

1. *Vîgadi Pandaga*.—The 1st Tithi (Lunar day) of the *Chaudes Sumvatsara*, called *Siddhanta Chandra mana* in the Carnatic, and reckoned in Bengal according to the style of *Vicramaditya*.

2. *Srîsâma-navamî*.—The 9th Tithi of the 1st Pâsha of the Lunar month Chaitra; which is the anniversary of the incarnation of Vishnu in the shape of a Rajah, or Prince of the cast of *Ushetrîa*.—A day of prayer and recreation, though some devout Brahmins keep fast.

3. *Madana-treyāḍī*.—A festival in honour of *Cāma dēva* the god of love. This is observed on the 13th Tithi of the 1st Pācsha of the Lunar month *Chaitra*; but principally in the Northern Provinces.

4. *Chittera Paurāṇī*.—The 14th Tithi or day of full Moon in *Chaitra*, on which day *Chittera Gupta* (the recording spirit of Yama's chancery) is commemorated.

5. *Balarāma Jayanti*; *Aśhāyā Trītiya*.—The 3d Tithi of the month *Vaiśākhā*, 1st Pācsha.—N. B. When certain days of the Moon fall on certain days of the week, they are called *Aśhāyā*, or imperishable. The present festival is subject to this contingency; but it is not considered so in the Carnatic.—This Tithi is the anniversary of the beginning of the *Tēta yug*; and a day of recreation.

6. *Nṛāṇḍa*, or *Narasīman Jayanti*.—The 14th Tithi of the 1st Pācsha of the Lunar month *Vaiśākhā*; being the anniversary of Viṣṇu's incarnation as half a lion, and half a man.

7. *Vyāsa Purnamī* or *Dānāmā vasyacam*.—The 15th Tithi or full Moon of the Lunar month *Aśvīṇḍa*, kept in commemoration of *Vyāsa* (one of the *Aṣṭarṣi*). He was one of the most celebrated Penitents, and the reputed author of the 18 principal, and 18 inferior *Paranas*, and also of all the *Mantras* or forms of prayer, in existence.

8. *Garuda Panchamī*; or *Nāga panchamī*.—The 5th Tithi of the Lunar month *Srāvāṇa*, on which day the serpent of Viṣṇu is worshipped.

9. *Vara Laxmī Vritam*.—(Moveable). This holy day is always kept on the Friday which precedes the full Moon of the Lunar month *Srāvāṇa*, reserved for Laxmī's worship.

10. *Rugopāṇa Cārmam*.—(Moveable); to be observed on the day when the Moon is in the Nakṣatra *Srāvāṇa*. The Brahmins begin to read the *Rig-veda* on this day.

11. *Ējorūpa Cārmam*.—The 13th Tithi, or day of full Moon of the Lunar month *Srāvāṇa*. On this day most of the Brahmins renew their sacrificial chord; and begin to read the *Ijor-veda*.

12. *Cāṣṭhina Janmāṣṭamī*.—The 8th Tithi of the 2d Pācsha of the Lunar month *Srāvāṇa*. The anniversary day of Viṣṇu's incarnation into the person of Śrī-Crishna.

13. *Somapa Cārmam*.—The 3d Tithi of the 1st Pācsha of the Lunar month *Bhādrapada*; on which the Brahmins who follow the doctrines of the *Soma-veda* renew their sacrificial chord; and begin to read that *vede*. (*)

14. *Pinayaka*, or *Gandā Chaturthī*; also *Harthāṣṭī*.—The 4th Tithi of the 1st Pācsha of the month *Bhādrapada*. An inauspicious day; because *Crishna* was falsely accused in his childhood to have stolen a gold gem from *Prasēna* on that day.

15. *Rishī panchamī*.—The 5th Tithi of the same month and Pācsha, on which the memory of the seven principal *Rishis* or penitents is commemorated.

16. *Ananta Chaturdasi*.—The 14th Tithi of the same month and Pācsha; sacred to Viṣṇu, under the epithet of *infinite*.

17. *Mūha lāgarāṇḍa*, or *Apurāṇa*, and *Brāhma sūtrā*.—The 1st Tithi of the 2d Pācsha

(*) The *Atharva-veda*, is either supposed to be lost, or to be considered as a lost book, and therefore never read (at least verbally) by the Brahmins.

of the Lunar month *Bhadra*, on which the Hindus begin to worship the *Pitris*, or spirits of deceased ancestors.

18. *Madhya Aetami*.—The 8th Tithi of the same Pacha and month; a day on which it is meritorious to observe the *Srardam*, which when done, produces the same effect as if that ceremony had been performed during every other day of the Pacha.

19. *Callagugudi*.—The 13th Tithi of the same month and Pacha; being the anniversary of the beginning of the *Call yug*.

20. *Navarâtrīcam*, or *Arzina Sudham*.—The 1st Tithi of the month *Arzina*, consecrated to the worship of the goddess *Durgâ*. On this day the *Dusseira* feast is celebrated. It is one of the most important and splendid of the year.

21. *Saraswati Pūja rumbha*.—(Movable); to be observed on the day when the Moon is in the *Nakshatra Mula* in the 1st Pacha of the month *Arzina*. On this day all Hindus begin to collect their books, and the instruments of their trade and profession, for the purpose of future adoration.

22. *Saraswati Pūja*, or *Mahânayami*.—The 9th Tithi of the 1st Pacha of *Arzina*; a day of devotion; bathing and reading certain *Mantras*.

23. *Vijayâ Desami*.—The 10th Tithi of the same Pacha and month; on this day are worshipped all the books, arms, and instruments of trade which were collected on *Saraswati Pūja rumbha*.

24. *Naraka chaturdasi*, or *Bhûta chaturdasi Yamaupanam*.—The 14th Tithi of the 2d Pacha of the month *Arzina*, on which *Yama* (the judge of the dead) is worshipped: the ceremonies performed on this day begin with the morning twilight or *Pratha Sandhya*.

25. *Dipavali*, or *Laxmi pūjâ dipavallâ*.—The 15th Tithi or day of full Moon of the month *Arzina*. On this day the Hindus begin to wear new clothes, and on that occasion entertain their friends: this is also the epoch for settling accounts, and hoarding up treasure. At midnight all the roineries of *Laxmi* shut up their money in a coffer, and worship it in honor of their tutelar goddess.

26. *Seunda-shasti*.—The 6th Tithi of *Cartica*, 1st Pacha. A day of fasting in honor of *Sakra mania*, son of *Siva*.

27. *Crita Yagodi* or *Durgâ navami*.—The 9th Tithi of the 1st Pacha of the month *Cartica*; and the anniversary of the beginning of the *Crita yug*.

28. *Uttarânicâdasi*.—The 11th Tithi of the 1st Pacha of the same month, the anniversary of that on which *Vishnu* awoke from his slumber of 4 months: a day for contemplation.

29. *Survalaya Deepam*, or *Dânamâvayamam*.—The 15th Tithi, or time of full Moon of the month *Cartica*: on this day all the pagodas and private houses are illuminated, and the rich entertain their friends.

30. *Cartica Deepam*.—(Movable); this festival depends on the day on which the Moon is in the *Nakshatra Cartica* during the month *Cartica*: it is a day of fasting in commemoration of *Sakra mania*.

31. *Mooroti Yacadesi*.—The 11th Tithi of the 1st Pacha of the month *Margasira*. A general

fast to be observed in honor of *Vishnu*, and kept all the day and night: no one should indulge in sleep during the whole course of the Tithi.

32. *Rudra*, or *Bancara Septami*.—The 7th Tithi of the 1st Pancha in *Māgha*. A fast in honor of the Son, as a form of *Vishnu*.

33. *Bhīma Jānānt*, or *Bhūmī*.—The 11th Tithi of the 1st Pancha in *Māgha*. Ceremonies to be performed with Tila or Sesamum, in honor of *Bhīma*.

34. *Maha Siva Rātri*.—The 14th Tithi of the 2d Pancha in *Māgha*. A rigorous fast to be kept, with extraordinary ceremonies in honor of *Shiva*, the *Phallus* of the Indians.

35. *Dusshara yugādi*.—The *Amāvasya* or conjunction day which determines the end of the Lunar month *Māgha*, being the anniversary of the beginning of the *Dusshara yug*.

36. *Camatohānam Holicā*, or *Phalgatrasva*; vulgarly called *Huli*.—The 15th Tithi or full Moon of the month *Phalguna*. This festival was ordained on account of the near approach of the Vernal Equinox. All classes of Hindus sport on this day in honor of *Gopinātha*, who is carried about in a palanquin. It may be compared to the *Saturnalia* of the Romans, for all classes of Society are confounded whilst it lasts.

37. *Pungol Uttarā*.—(Moveable); this festival, which is kept in commemoration of the marriage of *Siva*, *Vishnu* and other gods, is to be kept on the day when the Moon is in the *Nakshatra Phalguni*. On the above account this day is held auspicious for marrying.

Solar Festivals.

1. *Vāishākrāntim*.—The beginning of the Solar Syderal year; kept therefore on the 1st day of the month *Vāishāc'hā* (Tamil *Chitram*) when the Sun enters the Sign *Mēsha* ♈. This holy day is kept by resorting to the sacred rivers, giving alms, and sacrificing to the *Pitris*, or spirits of deceased ancestors: also a day of recreation.

2. *Deekhanayāda Pūnā Calam*.—The 1st day of the month *Srāvaṇa* (Tamil *Āṇṇ*) when the Sun enters *Carcatā* ♎. The same observances as for *Vāishāc'hā*.

3. *Āṇṇ Pūnāgu*.—The last day of the same month, a day of recreation and entertainment; on which the Hindus feast on boiled cocoanuts.

4. *Vīṣṇu Pūnā Calam*.—The 1st day of the month *Cārtika* (Tamil *Āṣvini*) when the Sun enters the Sign *Tulā* ♎; the same observances as for *Vāishāc'hā*.

5. *Uttarāyana Pūnā Calam*.—The 1st day of the Solar month *Magh* (Tamil *Tye*) when the Sun enters the Sign *Carcatā* ♎. This is the grand festival of the *Pungol*, on which day, after the usual bathings, giving of alms, and sacrifices to the *Pitris*, the Hindus offer boiled rice to the Sun, then scatter it over their fields to propitiate abundance. At the end of the ceremonies, they worship the Cow, and then it is pretended that some ill luck falls on a particular animal which becomes a victim for the general safety.

Māloo Pungol.—This is a continuation of the feast which began on the preceding day. The worship of the Cows and Bulls continues: all the cattle are decked with flowers, painted horns, &c. and driven about the fields, as if for their amusement.

N. B. For the anniversaries of the accession of the 14 Munis, see Text, page 311.



ERRATA.

PREFACE.

Page, Line.

- lii 4 from the top, for *Jyantish*, read *Jyôish*. The same correction in the 3d line from the bottom.
- vii 11 from the top, strike off the full stop . and read ;
- lx 2 from the bottom, for *Cycles*, read *Cycle*.
- xii 13 from the bottom, for *Phænomenæ*, read *Phænomena*.
- ib. in the same line, for 2h 24m, read 3h 53m or 22g 25v 30p Hindu time.

FIRST MEMOIR.

- 11 last word of the page, for *Ascendentia*, read *Antecedentia*.
- 17 13 from the top, for *at the end of the Tables*, read *in Appendix iv*, page 307.
- 20 1 of the note, for *Note*, read *Appendix ii*, page 245.
- 23 5 from the bottom, for *Cycle*, read *Style*.
- ib. last line of all, for Call.yugam 3102, read 003.2.
- 26 7 from the bottom, for *Ascendentia*, read *Antecedentia*.
- 29 13 from the bottom, for *could*, read *would*.
- 35 23 from the top, for *Ascendentia*, read *Antecedentia*.
- 39 11 from the bottom, for *let it be*, read *let be*.
- 40 16 from the bottom, for *Chronologists*, read *Chronologers*.
- 43 8 from the bottom, for *at*, read *with*.
- 45 1 of the note, for *Note*, read *Second Appendix*, page 307.
- 54 14 from the top, strike off the comma between "*less than*, and *for* ; and place it after *Rest*."
- ib. 17 from the top, for *is*, read *was*.

SECOND MEMOIR.

- 69 last figure in the Table at the bottom, for 25, read 24.
- ib. 7 from the top, for *Mukya*, read *Muc'hya*.
- 70 7 from the top, for *Sanyama*, read *Sangama*.
- 71 7 in the note, for *Narikar*, read *Naricoyr*.
- ib. last line of the note, for "*at the end of the Tables*", read *of the Volume*.
- 73 12 from the bottom, for "*Third Memoir*", read *Appendix to the Second Memoir*, page 109.
- 75 14 from the top, for *Baziya*, read *Bhalava*.
- ib. 8 from the bottom, for *lasts*, read *is*.
- ib. last line of all, for *third Memoir*, read *Appendix to the Second Memoir*.
- 76 16 from the top, strike off the stop after *Mahayug*) and of the following word strike off T, and read *the*.
- 77 11 from the top, for *Keta*, read *Ketu*.
- 81 12 from the bottom, for *Memoirs*, read *Memoir*.
- 84 8 of the note, for *Notation*, read *Nutation*.
- ib. last line but one of the note, for *Eppicûlar*, read *Epitircular*.
- 87 2 at top, for "*and the Amavasya*", read *and the ends of the Amavasya, and Prathamâ Trîtis*.
- 90 14 from the top, insert 45s over the quantity 23s 45v 32p and read thus

45s
— 23 45 32
16 14 22

- Page. Line.
 94 7 from the top, for "*let it be*," read *let be*.
 103 last line of all, the same correction.
 104 last note, for *Bouja*, read *Bhaja*.
 115 4 of the article C, after "*the Sun and Moon's*," add *relative (revolutions)*.
 117 1 in the note, strike off *Anavaga*.
 124 in the marginal note, for *Moon*, read *Sun*.
 127 9 from the top, for *Equation*, read *Motion*.
 130 4 from the bottom, for *Malaryan*, read *Malayala*.
 142 3 from the top, strike off 1.
 153 8 of Article 2, for *these*, read *those*.
 156 last line but one, for "*the time that will elapsed*," read *the time that will have elapsed*.

APPENDIX to the SECOND MEMOIR.

- 171 4 from the top, for *Josela Barcajosey*, read *Josela Bascarjosey*.

THIRD MEMOIR.

- 197 13 from the top, for *precedes*, read *precede*.
 ib. 15 from the top, for *those of the two*, read *one of the two*.
 ib. 4 from the bottom, for *inspection*, read *analogy*.
 209 10 from the top, at the beginning, strike off 24.
 200 7 from the top, for "*will be*," read *was*.
 201 2 from the top, for 353^d 17s 10^e 31p, read 353^d 27s 10^e 31p.
 204 1 of the note, for *Suda*, read *Sucla*.
 219 12 from the bottom, after *of the Call-yug*, add *be proposed*.

FOURTH MEMOIR.

- 220 in the note, for page 22 *infra*, read page 222.

APPENDIX II.

- 246 13 from the top, for *Chronologist*, read *Chronologer*.
 247 5 from the top, for *invention*, read *inventor*.
 255 2 from the bottom, in the sum of the Sun's mean Longitude, for 0° 35' 0" 52.9, read 0° 18' 0" 52.9.
 267 5 of proposition C, from the equation at the end, strike off = the sign of equality, and substitute \propto that of ratio.
 274 in the note, last line of figures, for $T = 26^d 8s 56p$, read $26^d 8s 0p$.
 ib. last line of the note, after "*which is the same as above*," add "*vide page 272*."
 279 in the computation of the Sun's apparent Longitude, at the bottom, wherever the word *Notation* appears, read *Nutation*.

APPENDIX III.

- 297 1 at the top, at its beginning, for "*the last of which is always of 355 days*," read "*Eleven of which are always of 355 days*."
 ib. wherever the words *Perdegird*, and *Perdegirdic* appears in this page, read *Feudegird* and *Yeudegirdic*.
 ib. 12 from the top, for *revolutions*, read *account*.
 298 4 from the bottom, for *Chronologist*, read *Chronologer*.
 299 7 from the top, for *Marsherran*, read *Marsherran*.
 302 8 from the top, for *Saidar*, read *Saidas*.
 304 6 from the bottom, for "*it fresh*," read *it fall*.
 ib. 5 from the bottom, for *Paa*, read *Pan*.

APPENDIX IV.

Page Line.

- 307 3 of the first paragraph, for "amount to six hours of time", read "amount to nearly six hours of time."
 309 14 from the top, at the end, for "before A", read *behind A*.
 318 in the heading of the second column of the Kalendar, for "or Chaitram", read "or Bengal Chaitra."

FRAGMENT I.

- 325 1 of the third paragraph, for *combals*, read *combates*.
 ib. 8 from the bottom, at the end, for "it proceeds $3^{\circ} \frac{1}{2}$ to $3^{\circ} \frac{1}{2}$ ", read "it proceeds from $3^{\circ} \frac{1}{2}$ to $5^{\circ} \frac{1}{2}$."
 329 3 from the top, near the end, for "it is constructed", read "it was constructed."

FRAGMENT IV.

- 336 2 & 3 of Article I, to "4926, of the Cali yug, and the 1737th since the birth of Sali-
 "rahana", add "*eclipsed*; the current years being 4927th of the Cali yug, and
 "1748th Saca."
 339 4 from the top, for the *Sun's* mean motion, read the *Moon's* mean motion.
 347 In the line of *Digits*, for $12^{\circ} 30'$, read $12^{\circ} 30'$, and the same of the two other quantities.

ASTRONOMICAL TABLES.

- 2 Table II, in the last line of the last paragraph, for *notation*, read *account*.
 19 Table XVII, 1st and 2d line of the title, for *corresponding*, read *relatively*.
 31 Table XXVI, for the word *Druza* inserted in the headings of the second columns of the Table, read *P'hala*.
 33 Table XXVII, Part I, in the second line after the Table, for "*origin Chaitram*," read "*origin of Chaitram*."
 ib. 7th line do. for "*of initial root*", read "*of the initial root*."
 34 Table XXVII, Part 2, second line of the title, strike off *and*.
 44 Table XXXIII, in the body of the Table, after *Benares*, the Hindu name *Cassi* of that city should be inserted; and for the same reason, after *Ogein*, should appear *Ujan*.
 65 Table XLIX, last line of all, after the words "*civil reckoning*", add "the difference 21°
 " $25' 48''$ ($8^{\circ} 34' 15''$, 2 E. T.) being only a fraction of the current day."

CHRONOLOGICAL TABLES.

Line.

- v 15 from the top, for "address himself to", read *address himself*.
 vii 16 from the bottom, for "on the 10th of April at $51^{\circ} 15''$ ", read "on the 10th April
 " (and Column XI) at $51^{\circ} 15''$."
 ix 2 from the top, at the beginning, for "11th April," read "(according to Dr. Wilson's
 communication) 12th April."
 xiii 15 from the top, for "or in the latter supposition", read "*but* in the latter supposition."
 xx 4 from the top, for "as we find an asterisk", read "as we find a B."

N. B.—For the Errata in the spelling of the Sanscrit terms, see the Glossary.



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TABLE I.

For finding the Initial Feria, and Sydercal beginning of any Solar Year, according to the
Tamil Kalendar: the duration of the year (that of the Arish Siddhanta) being 365d 15h
31. 15p. Vachij.

Drava.	Call. yog. 4802	Roots.				To be used with an Epoch.	
	Epoch or Drava. A. D. 1700	n. (0)	o. 2	r. 11	r. 15	Secular years,	Roots.
Roots	1	(1)	15	31	15	100	(5) 22 5 0
	2	(2)	31	2	30	200	(6) 44 10 0
	3	(3)	46	33	45	300	(6) 36 15 0
	4	(5)	2	5	0	400	(6) 38 20 0
	5	(6)	17	56	15	500	(6) 20 25 0
	6	(0)	33	7	30	600	(6) 12 30 0
	7	(1)	48	38	45	700	(6) 4 35 0
	8	(3)	4	10	0	800	(6) 56 40 0
	9	(4)	19	41	15	900	(3) 48 45 0
	10	(5)	35	12	30	1000	(5) 40 50 0
	20	(4)	10	25	0		
	30	(2)	45	37	30		
	40	(1)	30	50	0		
	50	(6)	56	2	30		
	60	(5)	31	15	0		
	70	(4)	6	27	30		
	80	(2)	41	40	0		
	90	(1)	16	52	30		
	100	(6)	52	5	0		

EXAMPLE.

For the year of the Call. yog 4847 current or
A. D. 1745.

	n.	o.	r.	r.
Epoch for 1700	(6)	2	11	15
Root for 40 years	(1)	20	50	0
Do. for 4 years	(5)	2	5	0

Root (5) 25 6 15
which Root (5) is to be counted from Sunday,
i. e. Friday, Sacra-vara.

N. B.—If the beginning of the year 1700 be required—

	n.	o.	r.	r.
Subtract Root for 1 year from the Epoch	(6)	2	11	15
Root for 1 year	(1)	15	31	15
Beginning of Chaitram and year Cal. 4802	(4)	46	40	0

Thursday, Gura-vara.

TABLE II.

For finding the Initial Ferla or Soota dina and Sydereal beginning of the Solar years of the Cycle of 60 years, called Grahaparivritih, as used in the Southern Provinces of the Peninsula, the year being of 365^d 12^r 31^v 30^v that of the Vakia Canon.

Sittandi.

For the beginning of the year Cm. 4847 (1745.)

First Epoch or A. Chali yug 2018 com- plete; or A. Ante Chris. 24.	Epochs of Cycles.		Roots of Years.	
	Cycles.	Epochs.	Years.	Roots.
		d. c.		d. c.
	0	(6) 3	0	(0) 0
	1	(0) 19	1	(1) 19
	2	(1) 38	2	(2) 31
	3	(2) 59	3	(3) 47
	4	(4) 10	4	(5) 2
	5	(3) 27	5	(6) 18
	6	(6) 44	6	(0) 33
	7	(1) 1	7	(1) 49
	8	(2) 18	8	(3) 4
	9	(3) 35	9	(4) 20
	10	(4) 52	10	(5) 25
	11	(6) 9	20	(4) 10
	12	(0) 26	20	(2) 45
	13	(1) 43	40	(1) 21
	14	(3) 0	50	(6) 36
	15	(4) 17	60	(5) 31
	16	(5) 34	70	(4) 6
	17	(6) 51	80	(2) 42
	18	(1) 8	90	(1) 17
	19	(2) 25		
	20	(3) 42		
	21	(4) 59		
	22	(6) 16		
	23	(0) 33		
	24	(1) 50		

EXAMPLE

of the Calendar, according to the Sittandi, for the year Chali yug 4847 current or A. D. 1745.

To determine the Cycle.

20)1745(19

31

add 23

58

Answer. 19th Cycle 58th year.

RULE.

Epoch Cycle 19 d. c. r.

Root for years 50 (2) 23

Ditto for 8 (8) 56

(3) 4

Epoch (5) 25 0

which being an even year, add + ,, 31

Beginning of year A. Chali, (5) 25 31

From which it appears that the beginning of the year and Chaitram falls after the 5th day from Sunday, i. e. Friday, at 25^r 31^v after Sun rise, which fraction of day being less than 30 guddins; marks the time before Sun set (at Lanka), and in this case the Civil and Sydereal notation agree.

According to the Vachij,

to the Sittandi

Difference

d. c. r. p.

(5) 25 6 15

(6) 25 31 0

31 ,, 24 45

TABLE III.

Exhibiting the *Tamul* names of the Solar months; their *absolute duration*; their *Roots*; and the *corresponding Signs of the Zodiac*.

I.			II.			III.					
Time ascribed to each Sign.			Roots of Indian Months separately taken.			Roots of Indian Months collectively taken.					
European months, Old Style.	Types of Signs of the Hindu Zodiac.	Tamil Months corresponding with Signs of the Zodiac.	The Longitude of the 1st of Mésa corresponding with the <i>Chaitram</i> to be taken 180° 41' 25" A. C. 1847 (1745.)			Types of Signs of the Hindu Zodiac.	Types of Signs and corresponding months of the European Zodiac.	This division to be used for finding at once the beginning of months of the European when that of the year has been found.	Names of the Hindu Signs of the Zodiac.	Names of the Hindu months of the Astronomical year.	European months.
			n. a. v. p.	n. a. v. p.	n. a. v. p.						
March	♈	Chaitram	30 55 32 1	(2) 55 32 1	(2) 55 32 1	♈	♈ April	(2) 55 32 1	Mésa	Vaisakh	April
April	♉	Vaisak	31 24 12 1	(3) 24 12 1	(3) 24 12 1	♉	♉ May	(6) 19 44 2	Vrischa	Jyestha	May
May	♊	Auni	31 38 28 1	(3) 38 28 1	(3) 38 28 1	♊	♊ June	(2) 38 22 2	Mithuna	Aslar	June
June	♋	Audi	31 28 12 2	(3) 28 12 2	(3) 28 12 2	♋	♋ July	(6) 24 24 6	Caradā	Bravann	July
July	♌	Avani	31 2 10 1	(3) 2 10 1	(3) 2 10 1	♌	♌ August	(2) 29 44 6	Siha	Bladras	August
August	♍	Pattani	30 27 22 1	(2) 27 22 1	(2) 27 22 1	♍	♍ September	(4) 34 6 7	Carya	Aswina	Sept.
Sept.	♎	Arpisi	29 54 7 1	(1) 54 7 1	(1) 54 7 1	♎	♎ October	(6) 48 13 8	Jula	Castiya	Oct.
Oct.	♏	Cariga	29 30 24 2	(1) 30 24 2	(1) 30 24 2	♏	♏ November	(4) 18 37 10	Vrischika	Margasira	Nov.
Nov	♐	Margali	29 50 53 1	(1) 50 53 1	(1) 50 53 1	♐	♐ December	(2) 32 30 11	Dhanu	Panshya	Dec.
Dec.	♑	Yay	29 27 16 1	(1) 27 16 1	(1) 27 16 1	♑	♑ January	(4) 6 46 12	Makara	Magh	Jan.
Jan.	♒	Maved	29 48 24 1	(1) 48 24 1	(1) 48 24 1	♒	♒ February	(3) 56 10 13	Cumbha	Phalguna	Feb.
Feb.	♓	Pooncon	30 20 21 2	(2) 20 21 2	(2) 20 21 2	♓	♓ March	(1) 15 31 14	Min	Chitra	March.

Peculiar attention is to be paid to the European month which concurs with *Chaitram*, which in present times is April, N. S. but in Old Style is March.—In that case, taking out the Root to get the beginning of the 2d month in the year, instead of taking that for April (2) 55 32 1, which is the first in the column, you are to take the same as for March.

How to find the beginning of any month in the year, by means of Table I and III.

EXAMPLE.

Having found by the Rule given at the foot of Table I, the manner of determining the 1st of Chaitram and year, according to the Vachij; and the same Table II, according to the Sittandij, let the 1st of the Tamil month Paratasi (Indian September) be required.

RULE.

<i>P=Alj.</i>		<i>Sittandij.</i>
Beginning of	d. c. v. r.	d. c. v. r.
Chaitram and year (5)	25 6 15	Annual Epoch (5) 25 31 0
Root Table III, part 3d, for Auvani (preceding month)		
complete, N. S.	(2) 26 44 6	Root Table III, part 3d, (2) 26 44 6
Beginning of Paratasi (0)	51 50 21	Indian September Sunday. (0) 52 13 6

But if we use the 2d part of Table III, instead of part 3d, we would have to begin from the month of Chaitram, and in order to reach the proposed Epoch to sum up successively the Roots for every month up to that of Paratasi.

EXAMPLE.

		<i>New Style.</i>
Beginning of Chaitram and year 4847		d. c. v. r.
Root for Chaitram, p. 2,	-	(5) 25 6 15 April
Beginning of Viassei,	-	(2) 55 32 1 for May
Root for Viassei,	-	(1) 20 38 16 May
Beginning of Auni,	-	(3) 24 12 1 for June
Root for Auni,	-	(4) 44 50 17 June
Beginning of Audi,	-	(3) 38 38 1 for July
Root for Audi,	-	(1) 21 28 18 July
Beginning of Auvani,	-	(3) 28 12 2 for August
Root for Auvani,	-	(4) 40 40 20 August
August.—Beginning of Paratasi,	-	(3) 2 10 1 for September
		(0) 51 50 21 September.

The same as before.

It need hardly be observed, that the beginning of the ensuing year may be obtained by going on adding the Roots as far as the month Poongoni.

TABLE IV.

For converting European hours, minutes and seconds, into Hindu guddias, viguddias, paras, suras; and vice versa.

European hours, minutes and seconds into Hindu Time.				Hindu guddias, viguddias and paras into European Time.			
European Time.	Hindu Time.	European Time.	Hindu Time.	Hindu Time.	European Time.	Hindu Time.	European Time.
H.	G. V.	H.	DAYS. G.	G.	H. M.	G.	H. M.
m. s.	v. p. p. s.	m. s.	g. v. v. p.	v. p.	m. s. s. *	v. p.	m. s. s. *
1	2 30	10	0 25	1	0 24	10	4 0
2	5 0	20	0 50	2	0 48	20	8 0
3	7 30	30	1 15	3	1 12	30	12 0
4	10 0	40	1 40	4	1 36	40	16 0
5	12 30	50	2 5	5	2 0	50	20 0
6	15 0	60	2 30	6	2 24	60	24 0
7	17 30			7	2 48		
8	20 0			8	3 12		
9	22 30			9	3 36		
10	25 0			10	4 0		

The use of this Table is familiar to all Mathematicians. I shall, however, give two Examples of its application.

EXAMPLE I.

To convert 15^h 21^m 35^s into Hindu time.

	G.	V.	P.	S.
Part 1st, 10 ^h =25				
5 ^h =12	30			
20 ^m =	50			
1 ^m =	2	30		
30 ^s =	1	15		
5 ^s =		12	50	
Answer	38	23	57	30

EXAMPLE II.

To convert 36^h 37^m 23^s into European Time.

	H.	M.	S.	*
Part 2d, 50 ^s =20				
6 ^s =2	24			
30 ^m =	12			
7 ^m =	2	48		
20 ^h =		8		
3 ^h =		1	12	
Answer	22	38	57	12

TABLE V.

For finding the Dominical Letter, Julian and Gregorian accounts.

PARTS FIRST AND SECOND.

Part 1st, Julian Secular years.										Part 2d, Gregorian Secular years.		
1	2	3	4	5	1	2	3	4	5	1	2	3
Years of Era Call yug current.	Concurrent Christian Secular years O. S.	Days of the week beginning each Christian century Julian Style.	Dominical Letter O. S.	Beginning of concurrent year Call yug O. S.	Year of Era Call yug current.	Concurrent Christian years O. S.	Days of the week beginning each Christian century Julian Style.	Dominical Letter O. S.	Beginning of concurrent year Call yug O. S.	Days of the week beginning each Christian century Gregorian Style.	Dominical Letter N. S.	Beginning of concurrent year Call yug N. S.
	A. D.			March.		A. D.			March.			April.
3102	0	Thursday	DC	14	4202	1100	Sunday	AG	23			
3202	100	Wednes	ED	14	4302	1200	Saturday	BA	24			
3302	200	Tuesday	FE	15	4402	1300	Friday	CB	25			
3402	300	Monday	GF	16	4502	1400	Thursday	DC	26			
3502	400	Sunday	AG	17	4602	1500	Wednes	ED	27	Monday	G	5
3602	500	Saturday	BA	18	4702	1600	Tuesday	FE	27	Saturday	BA	6
3702	600	Friday	CB	19	4802	1700	Monday	GF	28	Friday	C	8
3802	700	Thursday	DC	20	4902	1800	Sunday	AG	29	Wednesday	E	10
3902	800	Wednes	ED	20	5002	1900	Saturday	BA	30	Monday	G	12
4002	900	Tuesday	FE	21	5102	2000	Friday	CB	31	Saturday	BA	13
4102	1000	Monday	GF	22								

HEADS OF THE COLUMNS.

Part First.

1. Tamil Solar years counted from Epoch Call yugam current.
2. Christian Secular Julian years concurrent with the same.
3. Days of the week beginning each Christian century according to the Julian Calendar.
4. Dominical Letters of Christian Secular years O. S.
5. Date on which the concurrent Tamil year begins according to the Julian Calendar.

Part Second.

1. Days of the week on which the Christian century begins according to the Gregorian Calendar.
2. Dominical Letters of Christian Secular years N. S.
3. Date on which the concurrent Tamil year begins according to the Gregorian Calendar.

TABLE V.
PART THE THIRD.

Julian Secular years.					
1	2	3	4	5	6
Anno Ante Christian Aera.	Anno Mundi.	Anno from the Epoch Call yu- gam. + —	Dominical Letter O. S.	Day of the week be- ginning each Chris- tian century Julian style.	Day of the month on which the Hindu year begins.
4004 4000	1 (*) 4	Ante Call yug. — 903.2 — 898.7 Post Call yug. + 102 1102	DC FE	Thursday Tuesday	February 8 8
3000 2000	1004 2004		BA ED	Saturday Wednesday	16 23
1000 900 800 700	3504 3104 3204 3304	2102 2202 2302 2402	AG BA CB DC	Sunday Saturday Friday Thursday	March 5 6 7 7
600 500 400 300	3404 2504 3004 3703	2502 2602 2702 2802	ED FE GF AG	Wednesday Tuesday Monday Sunday	8 9 10 11
200 100 0	3504 2904 4004	2902 3002 3102	BA CB DC	Saturday Friday Thursday	12 13 14

SUPPLEMENT.

Julian Secular years from A. A. C. 1000.	Dominical Letter O. S.	Julian Secular years from A. A. C. 1000.	Dominical Letter O. S.	Julian Secular years from A. A. C. 1000.	Dominical Letter O. S.	Julian Secular years from A. A. C. 1000.	Dominical Letter O. S.
4000	FE	3100	AG	2200	CB	1300	ED
3900	GF	3000	BA	2100	DC	1200	FE
3800	AG	2900	CB	2000	ED	1100	GF
3700	BA	2800	DC	1900	FE	1000	AG
3600	CB	2700	ED	1800	GF		
3500	DC	2600	FE	1700	AG		
3400	ED	2500	GF	1600	BA		
3300	FE	2400	AG	1500	CB		
3200	GF	2300	BA	1400	DC		

(*) Port Royal account.

TABLE VI.

For finding the feria or weekly day which begins any proposed year.

This Table is always to be entered with the odd Christian year current of the century.

Part 1st, Julian Style.						
Number of days to be added to the day of the week beginning the Century for finding the 1st weekly day in the given year.						
0	1	2	3	4	5	6
Odd years of Centuries.						
* 0	6	7	8	14	9	16
11	12	13	14	20	15	21
22	17	24	19	25	26	27
33	23	30	31	32	33	34
44	24	35	36	42	37	44
55	40	46	41	48	43	49
66	45	52	47	53	54	55
77	51	57	58	59	60	61
88	62	63	64	70	65	72
99	68	74	69	76	71	77
100	73	80	75	81	82	83
111	84	79	85	86	87	88
122	89	90	91	92	93	94
133	95	96	97	98	99	100

Part 2d, Gregorian Style.						
Number of days to be added to the day of the week beginning the Century for finding the 1st weekly day in the proposed year.						
0	1	2	3	4	5	6
Odd years of Centuries.						
0	1	2	3	4	10	5
6	7	8	14	9	16	11
12	18	13	23	15	21	17
17	24	19	25	26	27	22
23	29	30	31	32	33	28
34	35	36	42	37	44	39
40	46	41	48	43	49	45
45	52	47	53	54	55	50
51	57	58	59	60	61	56
62	63	64	70	65	72	67
68	74	69	76	71	77	73
73	80	75	81	82	83	78
79	85	86	87	88	89	84
90	91	92	93	94	95	89
96	97	98	99	100	101	94

The construction and use of this Table are explained in the first Memoir. It is in all cases to be entered with the proposed current odd year of the Century.

For the years before Christ either Part first or second is to be used, as the given year happens to be a bissextile or a common one; a distinction, however, which does not apply to years after Christ.

TABLE VII.

Shewing the Epochs and Roots of Secular years from A. D. 0 to 2000.

The construction and use of this Table are explained in the first Memoir. The manner of using it is the same as that indicated at the foot of Table I, where the Epoch for 1700, marked at the top of the 1st column (6th) 2^d 11th 15th, is taken for the resolution of the beginning of A. Cn. 4847 (1745).

The 3d column exhibits the proper Roots of the Secular years which indicates at once its beginnings without the subtraction of one year from the Epoch for the same year, which is apt to occasion mistakes.

The Roots for the odd years are to be taken out of Table I.

1	2	3
European Secular years.	Concurrent years Call yugam commencing.	Epochs marking the beginning of the same Hindu year.
0	3102	D. C. Y. P. (0) 10 46 15
100	3202	(1) 8 51 15
200	3302	(1) 0 56 15
300	3402	(0) 53 1 15
400	3502	(0) 45 6 15
500	3602	(0) 37 11 15
600	3702	(0) 29 16 15
700	3802	(0) 21 21 15
800	3902	(0) 13 26 15
900	4002	(0) 5 31 15
1000	4102	(0) 57 35 15
1100	4202	(0) 49 41 15
1200	4302	(0) 41 46 15
1300	4402	(0) 33 51 15
1400	4502	(0) 25 56 15
1500	4602	(0) 18 1 15
1600	4702	(0) 10 6 15
1700	4802	(0) 2 11 15
1800	4902	(0) 54 15 15
1900	5002	(0) 46 21 15
2000	5102	(0) 38 26 15

EXAMPLE.

Wanted the beginning of A. D. 622, or Call yugam 3724 (545 Sacs).

By Table VII, 1st and 2d Part, Epoch for A. D. 600	D. C. Y. P.
Root for 20 years, by Table I.	(0) 29 16 15
Do, for 1 year complete Do.	(4) 10 23 0
	(1) 15 31 15

Beginning of Chaitram and year 3724 Call yugam or

545 Sacs - - - - Friday (5) 55 12 30

Succava.

The (5) in the 3d column shews at once that the Secular year 3702 Call yugam (A. D. 600) began on a *Saturday*, *Succava*, answering to the 19th March, O. S. both Civil and Syderal accounts.

TABLE VIII.

PART FIRST.

For years ascending from the birth of Christ, from 0 to 100.

Years of the First Century B. C. ascending.			
Years Anno Christ. Æra.	Anno Mund. (*)	Anno Cali yu- gam.	Roots indicating the beginning of each Tainul year.
100	3904	3002	b. o. v. r.
90	3914	3012	(0) 9 10 0
80	3924	3022	(5) 44 22 30
70	3934	3032	(4) 19 35 0
			(2) 54 45 30
60	3944	3042	(1) 30 0 0
50	3954	3052	(0) 5 12 30
40	3964	3062	(5) 40 20 0
30	3974	3072	(4) 15 37 30
20	3984	3082	(3) 30 50 0
10	3994	3092	(1) 25 2 30
0	3995	3093	(2) 41 33 45
8	3996	3094	(3) 57 5 0
7	3997	3095	(5) 12 35 15
6	3998	3096	(6) 28 7 30
5	3999	3097	(0) 43 38 45
4	4000	3098	(1) 59 10 0
3	4001	3099	(3) 14 41 15
2	4002	3100	(4) 30 12 30
1	4003	3101	(5) 45 43 45
0	4004	3102	(0) 1 15 0

The construction and use of this Table

are explained in the first Memoir.

Of this Table it is to be observed, that it gives the absolute Root for the beginning of years. That is to say, no Epoch is to be added to the quantity registered, in order to obtain the Syderal beginning of Chaitram and year falling within its limits.

If the beginning of a year from 10 to 100 B. C. be required, take the Root of the nearest one, and complete it with the Root of the intermediate years out of Table I.

EXAMPLE.

Let the Root for the beginning of the 24th year before Christ be required.

Take Root for 20 years, Table VIII	-	(2)	50	50	0
Do. for 4 years, Table I	-	(5)	2	5	0

Beginning of A. Cn. 3078 (B. C. 24) Thursday	(3)	48	45	0
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The same by the Epoch. A. D. 0 Ep.	-	(1)	16	46	15	Table VIII, part 2.
For 20 years, Table I	-	(4)	10	25	0	

Do. for 5 years Do.	-	(4)	6	21	15
	-	(6)	17	35	15

Beginning of Chaitram and year	-	(4)	48	45	0	the same as before
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TABLE VIII.

PART THE SECOND.

For years ascending from the birth of Christ O, to that of the Creation, according to the Mosiac system.

Years ascending to the Creation.					
Anno Abis Christian Æra.	Anno Mundi.	Concur- rent years Call yu- gam.	Epochs of Secular years.	Roots of Secular years.	Beginn- ing of Solar years, Julian.
(*) Origin of Time at Noon, Sunday.				D. M. Y. P. (0) 15 50 0	Feb'y. 8
4004	1	—503. 2	D. M. Y. P. (2) 46 52 30	(1) 31 21 15	8
4000	4	—508. 7	(6) 33 29 15	(5) 17 55 0	8
3000	1004	102	(5) 14 10 15	(3) 58 45 0	16
2000	2004	1102	(3) 55 0 15	(2) 59 35 0	25
1000	3004	2102	(1) 25 55 15	(1) 20 25 0	March 5
900	3104	2202	(2) 28 1 15	(1) 12 30 0	6
800	3204	2302	(2) 20 6 15	(1) 4 35 0	7
700	3304	2402	(2) 12 11 15	(0) 66 40 0	7
600	3404	2502	(2) 4 16 15	(0) 48 45 0	8
500	3504	2602	(1) 50 21 15	(0) 40 50 0	9
400	3604	2702	(1) 42 26 15	(0) 32 55 0	10
300	3704	2802	(1) 40 31 15	(0) 25 0 0	11
200	3804	2902	(1) 32 36 15	(0) 17 5 0	12
100	3904	3002	(1) 24 41 15	(0) 9 10 0	13
0	4004	3102	(1) 16 46 15	(0) 1 15 0	14

The construction and use of this Table are explained in the last Section of Part 1st of the first Memoir. Its application differs in nothing from that of Table VII, excepting that if the Epochs are used for expounding the beginnings of the Hindu years, one year is to be *added* instead of *subtracted* (for having the complete Solar year ending) to the notation of the proposed year; because the years before Christ are noted *increasing* whilst *ascending*, as is exemplified in the Rule at the foot of the preceding page.

(*) It may be worth noticing, that in calculating the beginning of the Solar Systemal year of the Creation according to the Mosiac system, by the Hindu formula, it falls on a Sunday, 8th February, very near noon, the difference being only 20 minutes European time.

TABLE IX.

Exhibiting the Dominical Letter for every day in the year.

January.		February.		March.		April.		May.		June.		July.		August.		September.		October.		November.		December.	
1	A	1	d	1	d	1	f	1	b	1	e	1	A	1	c	1	f	1	A	1	d	1	f
2	b	2	e	2	e	2	A	2	c	2	f	2	b	2	d	2	A	2	b	2	e	2	g
3	c	3	f	3	f	3	b	3	d	3	g	3	c	3	e	3	g	3	c	3	f	3	A
4	d	4	g	4	g	4	c	4	e	4	A	4	d	4	f	4	d	4	d	4	g	4	b
5	e	5	A	5	A	5	d	5	f	5	b	5	e	5	A	5	c	5	e	5	A	5	c
6	f	6	b	6	b	6	e	6	g	6	c	6	f	6	b	6	d	6	f	6	b	6	d
7	g	7	c	7	c	7	f	7	d	7	d	7	g	7	c	7	e	7	g	7	c	7	e
8	A	8	d	8	d	8	g	8	b	8	e	8	d	8	A	8	f	8	d	8	e	8	f
9	b	9	e	9	e	9	A	9	c	9	f	9	e	9	b	9	A	9	b	9	e	9	A
10	c	10	f	10	f	10	b	10	d	10	g	10	b	10	c	10	A	10	c	10	f	10	b
11	d	11	g	11	g	11	c	11	e	11	A	11	c	11	f	11	b	11	e	11	g	11	c
12	e	12	A	12	A	12	d	12	f	12	b	12	d	12	g	12	c	12	f	12	A	12	e
13	f	13	b	13	b	13	e	13	g	13	c	13	e	13	A	13	d	13	g	13	b	13	d
14	g	14	c	14	c	14	f	14	d	14	d	14	f	14	b	14	e	14	d	14	c	14	e
15	A	15	d	15	d	15	g	15	b	15	e	15	g	15	c	15	f	15	e	15	d	15	f
16	b	16	e	16	e	16	A	16	c	16	f	16	A	16	d	16	g	16	b	16	e	16	g
17	c	17	f	17	f	17	b	17	d	17	g	17	b	17	e	17	A	17	c	17	f	17	A
18	d	18	g	18	g	18	c	18	e	18	A	18	c	18	f	18	b	18	d	18	g	18	b
19	e	19	A	19	A	19	d	19	f	19	b	19	d	19	g	19	c	19	e	19	A	19	c
20	f	20	b	20	b	20	e	20	g	20	c	20	e	20	A	20	d	20	f	20	b	20	d
21	g	21	c	21	c	21	f	21	d	21	d	21	f	21	b	21	e	21	g	21	c	21	e
22	A	22	d	22	d	22	g	22	b	22	e	22	g	22	c	22	f	22	A	22	d	22	f
23	b	23	e	23	e	23	A	23	c	23	f	23	A	23	d	23	g	23	b	23	e	23	g
24	c	24	f	24	f	24	b	24	d	24	g	24	b	24	e	24	A	24	c	24	f	24	A
25	d	25	g	25	g	25	c	25	e	25	A	25	c	25	f	25	b	25	d	25	g	25	b
26	e	26	A	26	A	26	d	26	f	26	b	26	d	26	g	26	c	26	e	26	A	26	c
27	f	27	b	27	b	27	e	27	g	27	c	27	e	27	A	27	d	27	f	27	b	27	d
28	g	28	c	28	c	28	f	28	d	28	d	28	f	28	b	28	e	28	g	28	c	28	e
29	A	29	d	29	d	29	g	29	b	29	e	29	g	29	c	29	f	29	A	29	d	29	f
30	b	30	e	30	e	30	A	30	c	30	f	30	A	30	d	30	g	30	b	30	e	30	c
31	c	31	f	31	f	31	b	31	d	31	g	31	b	31	e	31	A	31	c	31	f	31	A

TABLE X.

Table showing some of the forms assumed by the months of the mean Solar Tamil year, with reference to the Gregorian Style.

The twelve months of the year Call yug 4847 (A. D. 1745.6).					The twelve months of the year Call yug 4856 (1754.7).					The twelve months of the year Call yug 4856 (1813.14).				
Names of Tamil months.	Roots of beginnings of months, with fractions.	Days of the week commencing	Concurrent Christian date.	Number of days in each month.	Roots of beginnings of months, with fractions.	Days of the week commencing	Concurrent Christian date.	Number of days in each month.	Roots of beginnings of months, with fractions.	Days of the week commencing	Concurrent Christian date.	Number of days in each month.		
1745 Chaitram	n. a. v. p. (5) 25 6 15	Friday	1745 9 April	31	n. a. v. p. (2) 44 47 50	Tues	1754 9 April	31	1813 (0) 0 31 15	Sunday	11 April	30		
Vaisak	(1) 20 38 15	Mon	10 May	31	(3) 40 39 51	Friday	10 May	32	D.L. (2) 30 3 16	Tues	11 May	32		
Amavasi	(4) 44 50 17	Thurs	10 June	32	(2) 4 31 22	Tues	11 June	31	C (6) 50 15 17	Satur	12 June	31		
Asad	(1) 21 28 18	Mon	12 July	31	(3) 41 0 33	Friday	12 July	32	(2) 56 53 18	Tues	13 July	32		
Asvini	(4) 49 40 20	Thurs	12 Aug	31	(2) 9 21 35	Tues	13 Aug	31	(6) 25 5 20	Satur	14 Aug	31		
Parasari	(0) 51 50 31	Sunday	12 Sept	31	(3) 11 21 36	Friday	13 Sept	30	(2) 27 15 21	Tues	14 Sept	30		
Asvini	(3) 19 12 22	Wed	13 Oct	30	(0) 38 33 37	Sunday	13 Oct	30	(4) 34 37 22	Thurs	14 Oct	30		
Cartiga	(5) 12 19 23	Friday	12 Nov	29	(2) 33 0 38	Tues	12 Nov	30	(6) 48 44 23	Satur	13 Nov	30		
Margali	(0) 43 43 25	Satur	11 Dec	29	(4) 3 21 40	Thurs	12 Dec	30	(1) 19 8 25	Mon	13 Dec	30		
1746 Tyo	(1) 4 26 26	Mon	1745 10 Jan	30	(3) 24 17 41	Friday	10 Jan	29	B (2) 40 1 20	Tues	11 Jan	29		
Masali	(2) 31 32 27	Tues	8 Feb	29	(6) 31 23 12	Satur	8 Feb	30	1814 (4) 7 17 27	Thurs	10 Feb	30		
Pongoni	(4) 20 16 28	Thurs	10 Mar	30	(1) 39 37 43	Mon	10 Mar	30	(2) 25 41 28	Friday	11 Mar	29		
4848 Chaitram	(6) 40 37 30	Satur	9 April	30	(4) 0 18 45	Thurs	10 April	31	(1) 16 2 30	Mon	11 April	31		

Common 305 days

Leap 306 days

Common 305 d.

TABLE X, continued.
Forms of Tamil years assumed with reference to the Julian Style.

The twelve months of the year Cali yug 4847. (*)					The twelve months of the year Cali yug 3003.				
Names of Tamil months.	Roots of beginnings of months, with fractions.	Days of the week commencing month.	Concurrent date.	Number of days in each month.	A.D.	Roots of beginnings of months, with fractions.	Days of the week commencing month.	Concurrent date.	Number of days in each month.
1745 Chaitram	D. L. F	Friday	29 Mar	31	801	(0) 12 26 35	Sunday	21 Mar	31
Vaisak	(2) 25 6 15	Monday	29 April	31	D.L.	(3) 8 28 16	Wed	21 April	31
Asad	(1) 20 38 16	Thursday	30 May	31	C	(5) 33 19 17	Satur	22 May	32
Asad	(4) 44 50 17	Monday	(*) 1 July	32		(3) 9 48 18	Wed	23 June	31
Asad	(1) 21 28 18	Thursday	1 Aug	31		(6) 28 0 20	Satur	24 July	31
Asad	(4) 49 40 20	Sunday	1 Sept	31		(2) 40 10 21	Tuesday	24 Aug	31
Asad	(0) 51 50 21	Wednesday	2 Oct	30		(3) 7 22 22	Friday	24 Sept	30
Asad	(3) 19 12 22	Friday	1 Nov	29		(0) 1 29 23	Sunday	24 Oct	29
Asad	(5) 13 10 23	Saturday	30 Nov	30		(1) 32 3 25	Monday	22 Nov	29
Asad	(6) 43 43 25	Monday	20 Dec	30		(2) 52 56 26	Tuesday	21 Dec	30
1746 Tye	(1) 4 36 26	Tuesday	28 Jan	29	802	(4) 20 12 27	Thursday	20 Jan	30
Maasi	D. L. E	Thursday	27 Feb	30	B	(6) 8 26 28	Satur	19 Feb	30
Pongol	(2) 31 52 27	Saturday	29 Mar	30		(1) 28 57 30	Monday	21 Mar	30
Chaitram	(4) 26 16 28			305					
Chaitram	(6) 40 57 30								

(*) It is to be remarked, in the construction of the year Cali yug 4847, concurrent with our A. D. 1745.6, that no Hindu month begins in our June (Julian Calendar) and that the beginning of both Car-tige and Margali fall in our November, a circumstance which, if unattended to, might perplex a great deal the computer, and throw much confusion in the operation for converting dates from one Style into the other.

TABLES OF JUPITER.

Tables, for computing the rank, name, and beginning of the years of the Cycle of 60 or Vrihaspati, computed relatively to the commencement of the concurrent Solar Sydereal year, according to the precept of the Surrish Siddhanta and Commentary.

TABLE XI.

Jupiter's mean heliocentric motion for Solar years uncorrected, according to the Surrish Siddhanta.

I					II					III				
Years.	Ψ's mean motion.				Years.	Ψ's mean motion.				Years.	Ψ's mean motion.			
	Signs	'	"	'''		Rev.	S.	'	"		Rev.	S.	'	"
1	1	0	21	6	10	0	10	3	31	100	8	5	5	10
2	2	0	42	12	20	1	8	7	2	200	16	10	10	20
3	3	1	3	18	30	2	6	10	33	300	25	3	15	30
4	4	1	24	24	40	3	4	14	4	400	33	8	20	40
5	5	1	45	30	50	4	2	17	35	500	42	1	25	50
6	6	2	6	36	60	5	0	21	6	600	50	7	1	0
7	7	2	27	42	70	5	10	24	37	700	59	0	0	10
8	8	2	48	48	80	6	8	28	8	800	67	5	11	20
9	9	3	9	54	90	7	7	1	39	900	75	10	16	30
10	10	3	31	0	100	8	5	5	10	1000	84	3	21	40
R. S. ' " ' "														
Drava A. Calliyugam complete 4100 = 370° 11' 17" 20 0.											2000	168	7	13 20
											3000	252	11	5 0
											4000	337	2	20 40
											5000	421	6	18 20

TABLE XII.

Annual Increment, or Equation of Ψ's mean heliocentric Longitude, according to the Tika, at the rate of 8 Revolutions in a Maha yug, as used in present times.

I		II		III	
Years.	Increment.	Years.	Increment.	Years.	Increment.
	' "		' "		' "
1	2 24	10	0 24	100	" 4'
2	4 48	20	0 48	200	" 8
3	7 12	30	1 12	300	" 12
4	9 36	40	1 36	400	" 16
5	12 0	50	2 0	500	" 20
6	14 24	60	2 24	600	" 24
7	16 48	70	2 48	700	" 28
8	19 12	80	3 12	800	" 32
9	21 36	90	3 36	900	" 36
10	24 0	100	4 0	1000	" 40
Drava A. Cal. complete 4100 = 2° 58' 0".					
				2000	1° 20
				3000	2 0
				4000	2 40
				5000	3 20

TABLE XIII.

For converting Jupiter's mean heliocentric motion corrected into mean Solar Sydercal time, the year being 365² 154 31² 51² 00².

I					II					III					IV				
Days.		Dandas.		Palas.	Castaculas.	Days.		Dandas.		Palas.	Castaculas.	Days.		Dandas.		Palas.	Castaculas.		
1	12	2	4	9,4744	1	0	12	2	4,1379	1	0	12	2,0693	1	0	12,0344			
2	24	4	8	18,9489	2	0	24	4	8,2758	2	0	24	4,1386	2	0	24,0690			
3	36	6	12	28,4232	3	0	36	6	12,4373	3	0	36	6,2079	3	0	36,1034			
4	48	8	16	37,8977	4	0	48	8	16,5313	4	0	48	8,2772	4	0	48,1388			
5	60	10	20	47,3722	5	1	0	10	20,7805	5	1	0	10,3463	5	1	0,1724			
6	72	12	24	56,8466	6	1	12	12	24,0374	6	1	12	12,4157	6	1	12,2070			
7	84	14	28	6,3210	7	1	24	14	28,1083	7	1	24	14,4850	7	1	24,2414			
8	96	16	32	15,7954	8	1	36	16	32,2653	8	1	36	16,6543	8	1	36,2758			
9	108	18	37	25,2699	9	1	48	18	37,4219	9	1	48	18,6236	9	1	48,3103			
10	120	20	41	34,7443	10	2	0	20	41,5791	10	2	0	20,6929	10	2	0,2448			
20	240	41	28	9,4896	20	4	0	41	23,1567	20	4	0	41,3859	20	4	0,0897			
30	361	2	4	41,2329	30	6	0	2	4,7372	30	6	0	2,0789	30	6	1,0348			
					40	8	1	22	46,3163	40	8	1	22,7719	40	8	1,3796			
					50	10	1	42	27,8954	50	10	1	43,4649	50	10	1,7244			
					60	12	2	4	9,4744	60	12	2	4,1379	60	12	2,0699			

TABLE XIV.

For converting the fraction of the first term of the Jyautistava Rule into Saura time, the Solar year being of 360 days, $\frac{1}{1171}$ expressing such a Saura year.

I				II				III			
Numerators	Days.			Numerators	Days.			Numerators	Days.		
1	0	11	31,2	10	1	45	12	100	10	12	
2	0	23	2,4	20	3	60	24	200	58	24	
3	0	34	35,6	30	6	45	30	300	87	36	
4	0	46	4,8	40	7	40	48	400	76	48	
5	0	57	26,0	50	9	36	0	500	96	0	
6	1	9	7,2	60	11	31	12	600	115	12	
7	1	20	38,4	70	13	26	24	700	134	24	
8	1	32	9,6	80	15	21	36	800	153	36	
9	1	43	40,8	90	17	16	48	900	172	48	
10	1	55	12,0	100	19	12	0	1000	192	0	

EXAMPLES TABLE XIV.

Let it be required to convert the fraction $\frac{1}{1171}$ into Saura time.
 By Table XIV, - 1000 - 192² 0' 0"
 - 800 - 153 36 0
 - 50 - 9 36 0
 - 4 - 46 4,8
 Saura time sought - - 356 58 4,8

TABLE XV.

I.

*Degrees of ☉'s motion
reduced to Saura time.*

II.

*Saura time reduced to degrees,
&c. of ☉'s motion.*

Degrees.	Days.	°	'	Days, Dandas, Castakalas.	Months of 30 days.	°	'	Days, Dandas, Castak.	°	'	°
1	12	1	0	12	1	2	30	1	0	5	
2	24	2	0	24	2	5	0	2	0	10	
3	36	3	0	36	3	7	30	3	0	15	
4	48	4	0	48	4	10	0	4	0	20	
5	60	5	1	0	5	12	30	5	0	25	
6	72	6	1	12	6	15	0	6	0	30	
7	84	7	1	24	7	17	30	7	0	35	
8	96	8	1	36	8	20	0	8	0	40	
9	108	9	1	48	9	22	30	9	0	45	
10	120	10	2	0	10	25	0	10	0	50	
20	240	20	4	0	11	27	30	20	0	40	
30	360	30	6	0	12	30	0	30	0	30	
		40	8	0				40	3	20	
		50	10	0				50	4	10	
		60	12	0				60	5	0	

EXAMPLE TABLE XIII.

Let it be required to convert $16^{\circ} 44' 24''$ of Jupiter's motion, into Solar Syderal time.

	D.	G.	V.	P.
10°	-	-	2	0 20 41,6793
6°	-	-	1	12 32 24,9474
$40''$	-	-	8	1 22,7719
$4''$	-	-		48 6,2772
$20''$	-	-		4 0,6897
$4''$	-	-		48,1280

Solar Syderal time sought - - 3 21 27 25,4033

EXAMPLE TABLE XV.

I. Degrees into Time.

Let it be required to convert $27^{\circ} 31' 6''$ of the Sun's motion into Saura time, of 1 day to 1°.

	D.	G.	V.
20°	-	240	0 0
7°	-	84	0 0
$30'$	-	5	0 0
$1''$	-		12 0
$6''$	-		1 12

Time sought - 330 13 12

or 11 months of 30 days 04 132 12°.

II. Time into Degrees.

Let it be required to convert 11 months (of 30 days or 330^d), 04 132 12° into degrees.

	°	'	°	°
11 months	-	27	30	0 0
0 days	-	0	0	0 0
10 gud.	-	0	0	50 0
3	-	0	0	15 0
10 vig.	-	0	0	0 20
2	-	0	0	0 10

Degrees, &c. sought - 27 31 6 0

TABLE XVI.

For converting Saura time of one day to a degree, to mean Solar Sydereal time, the year being 365^d 15^h 31^m 15^p.

I				II			III	
Saura Days.	Days.	Guddias.	Vigud.	Saura Dandas.	Guddias.	Vigud.	Saura Palas.	Vigud.
1	1	0	32,58681	1	1	0,87644	1	1,01460
2	2	1	45,17361	2	2	1,75289	2	2,02921
3	3	2	37,76042	3	3	2,62934	3	3,04381
4	4	3	30,34722	4	4	3,50578	4	4,05842
5	5	4	22,93403	5	5	4,38223	5	5,07303
6	6	5	15,52083	6	6	5,25868	6	6,08763
7	7	6	8,10764	7	7	6,13513	7	7,10224
8	8	7	0,69444	8	8	7,01157	8	8,11684
9	9	7	53,28124	9	9	7,88802	9	9,13145
10	10	8	45,86805	10	10	8,76447	10	10,14607
20	20	17	31,73610	20	20	17,52894	20	20,29215
30	30	26	17,60415	30	30	26,29340	30	30,43822
40	40	35	3,47220	40	40	35,05787	40	40,58429
50	50	43	49,34025	50	50	43,82234	50	50,73037
60	60	52	35,20835	60	60	52,58681	60	60,87644
70	71	1	21,07640					
80	81	10	6,94445					
90	91	18	52,81250					
100	101	27	38,68055					
200	202	55	17,36110					
300	304	22	56,04165					

EXAMPLE TABLE XVI.

Let it be proposed to convert 355^d 49 dandas, 29,05 palas, expressed in Saura time, into Solar Sydereal time, the year being 365^d 15^h 31^m 15^p.

Saura.		Sydereal.	
		n. cup.	vigud.
Column I	300d - -	304	22 56,04165
	50 - -	50	43 49,34025
	5 - -	5	4 22,93403
II	40dca. - -	40	35,05787
	9 - -	9	7,88802
	20palas. - -		20,29215
III	9 - -		9,13145
	0,2 - -		0,01345
	0,05 - -		0,05073
Total in Solar Sydereal time		351	1 31,64960

TABLE XVII.

Exhibiting the progress of Jupiter in degrees, &c. for Solar years of 3650 134 31p 31c corresponding to Vrihaspati years of 3610 24 4p 44c, 2329 as deduced from the precepts of the Surriah Siddhanta and Tika.

I.							II.					
Solar Years.	Jupiter's mean heliocentric revolutions and parts.						Corresponding duration of \mathcal{Y} 's time, its year being 3610 24 4p 44c, 2329 of Solar time, the rest being expressed in Solar time.					
	Rev.	Signs.	'	"	'	"	Yrs.	Days.	Das.	Pal.	Cast.	
1.	0	1	0	31	3	36	1	4	13	25	46,7655	
2	0	2	0	42	7	12	2	8	26	43	33,5310	
3	0	3	1	3	10	48	3	12	40	20	20,2965	
4	0	4	1	24	14	24	4	16	53	47	7,0620	
5	0	5	1	45	18	0	5	21	7	13	53,8274	
6	0	6	2	6	21	36	6	25	20	40	40,5930	
7	0	7	2	27	25	12	7	29	34	7	27,3584	
8	0	8	2	48	28	48	8	33	47	34	14,1239	
9	0	9	3	9	32	24	9	38	1	1	0,8894	
10	0	10	3	30	36	0	10	42	14	27	47,6552	
20	1	8	7	1	12	0	20	87	28	53	35,3104	
30	2	6	10	31	48	0	30	126	43	23	22,0656	
40	3	4	14	2	24	0	40	168	57	51	10,6208	
50	4	2	17	33	0	0	50	211	12	18	68,2760	
60	5	0	21	3	36	0	60	253	26	46	45,9312	
70	5	10	21	34	12	0	70	295	41	14	33,6864	
80	6	8	28	4	48	0	80	337	55	42	21,2416	
90	7	7	1	35	24	0	91	19	8	5	24,6639	
100	8	5	5	5	0	0	101	61	22	33	12,3400	

EXAMPLE TABLE XVII.

1^o. Wanted the number of Jupiter's mean heliocentric revolutions and parts in 175 Solar years.

						R.	S.	'	"	'	"
Part I, for 100 Solar years						8	5	3	6	0	
70 do.						5	10	24	34	12	
5 do.						0	5	1	45	18	
Answer						14	9	1	25	30	

2^o. Wanted the time in terms of Jupiter's own year, answering to 175 Solar years.

						Y.	D.	DAS.	P.	C.
Part II, for 100 Solar years						101	61	22	33	12,3400
70 do.						70	295	41	14	33,6864
5 do.						5	21	7	13	53,8274
As the days exceed 1 of \mathcal{Y} 's years						175	378	11	1	29,7234
Subtract 1 year						361	2	4	44,2329	

TABLE XVIII.

Exhibiting the Epochs of expunged years of the Cycle of 60 years, from the beginning of the Culing to A. 5128, in mean Solar Spherical time.

Epochs in Christian years A. C.	Periods.	V's mean heliocentric Longitude.		Years.	Days.	Dandas.	Palas.	Castucalas.	V's mean heliocentric Longitude.	Years.	Days.	Dandas.	Palas.	Castucalas.	Periods.	Epochs in Christian years A. C.	
		n.	s.														
3046	1	4	8	55	129	42	31	52,0636	343	8	3839	30	13	6	57,6152	45	738
2950	2	11	11	141	125	23	13	34,4625	350	11	3925	27	58	48	40,0141	46	824
2874	3	19	9	227	124	13	55	16,3614	353	2	4011	25	44	20	22,4130	47	910
2788	4	26	5	313	121	59	36	59,2603	345	5	4097	23	50	12	4,8110	48	996
2702	5	33	8	399	119	45	18	41,0592	352	8	4183	21	15	53	47,2108	49	1082
2616	6	40	11	485	117	31	0	24,0581	359	11	4269	19	1	55	22,6097	50	1168
2530	7	48	2	571	115	16	42	6,4570	367	2	4355	16	47	17	12,0086	51	1254
2444	8	55	5	657	113	2	43	48,8559	374	5	4441	14	32	58	64,4075	52	1340
2358	9	62	8	743	110	48	5	31,2548	381	8	4527	12	18	40	36,8064	53	1426
2272	10	69	11	829	108	53	47	15,6537	388	11	4613	10	4	22	19,2053	54	1512
2186	11	77	2	915	105	19	28	56,0526	395	2	4699	7	50	4	1,6042	55	1598
2100	12	84	5	1001	104	5	10	38,4515	403	5	4785	5	35	43	44,0931	56	1684
2014	13	91	8	1087	101	50	52	50,8504	410	8	4871	3	21	27	26,4920	57	1770
1928	14	98	11	1173	99	36	34	3,2493	417	11	4957	1	7	9	2,8009	58	1856
1842	15	106	2	1259	97	22	15	45,6482	425	2	5042	364	8	22	22,1998	59	1941
1756	16	113	5	1345	95	7	57	28,0471	432	5	5128	351	54	4	4,5987	60	2027
1670	17	120	8	1431	92	53	39	10,4460									
1584	18	127	11	1517	90	39	20	52,8449									
1498	19	135	2	1603	88	25	2	35,2438									
1412	20	142	5	1689	86	10	44	17,6427									
1326	21	149	8	1775	83	56	26	0,0416									
1240	22	156	11	1861	81	42	7	42,4405									
1154	23	164	2	1947	79	27	49	24,8394									
1068	24	171	5	2033	77	13	31	7,2383									
982	25	178	8	2119	74	59	12	40,6372									
896	26	185	11	2205	72	44	54	22,0361									
810	27	193	2	2291	70	30	56	14,4350									
724	28	200	5	2377	68	16	17	56,8339									
638	29	207	8	2463	66	1	59	39,2328									
552	30	214	11	2549	63	47	41	21,6317									
466	31	222	2	2635	61	33	23	4,0306									
380	32	229	5	2721	59	19	4	46,4295									
294	33	236	8	2807	57	4	46	28,8284									
208	34	243	11	2893	54	50	28	17,2273									
122	35	251	2	2979	52	36	9	59,6262									
36	36	258	5	3065	50	31	51	36,0251									
A.D. 50	37	265	8	3151	48	7	33	18,4240									
130	38	272	11	3237	45	53	15	0,8229									
222	39	280	2	3323	43	38	56	43,2218									
308	40	287	5	3409	41	24	38	25,6207									
394	41	294	8	3495	39	10	20	8,0196									
480	42	301	11	3581	36	56	1	50,4185									
566	43	309	2	3667	34	41	42	32,8174									
652	44	316	5	3753	32	27	23	15,2163									

EXAMPLE I.

Wanted the year of the Chacra which concurs with
A. Call yugam 35 complete, or 56 current.

I.

For V's mean heliocentric Longitude.

Table XI, for 60	n.	s.	-	-	-
Do.	5	-	4	2	17 35 0
Bijah	-	-	5	1	43 30
Table XII	-	-	4	7	19 20 30
	-	-	-	2	12

50 - 2 0 } Seht. - 4 7 15 18 18
5 - 12 } from + 4 7 30 to complete the
2 12 } Sign. Wanting 10 41 42

To convert which into time.

	n.	s.	p.	c.
Table XIII, 10	120	20	41	24,7443
40	8	1	22	45,3163
1	-	12	2	4,1579
40	-	8	1	22,7719
2	-	-	24	4,1886

10° 41' 42" = 128 42 31 32,1296
By Table XVIII 32,0636

EXAMPLE I.

Wanted the year of the Chacra which concurs with
A. Call yugam 55 complete, or 56 current.

1.

For V's mean heliocentric Longitude.

Table XI, for 60 . . . 4 2 17 55 0

Do. 5 . . . 5 1 43 30

Epoch . . . 4 7 19 20 30

Table XII . . . = 2 12

50 - 2 0 } Subt. = 4 7 15 18 18

5 - 12 } from + 4 7 30 to complete the

2 12 } Sign. Wanting 10 41 42

To convert which into time.

Table XIII, 10 . . . 120 20 41 24,7443

40 . . . 8 1 22 46,3163

1 . . . 12 2 4,1579

40 . . . 8 1 22,7719

2 . . . 24 4,1886

10° 41' 42" = 128 42 31 52,1296

By Table XVIII 52,0636

Difference of the Tables 0,0660

$$\text{Lastly, } \frac{4 \times 12 + 3}{60} = 55 \text{ years } (\Psi's.)$$

The first expunged year of the Chakra after the Epoch Caliyugam is, therefore, due when 557 1280 420 312 520 Solar time, have expired, and Ψ 's Longitude is precisely (42) 84.

EXAMPLE II.

For the nearest expunged year of the Chakra to A. Caliyugam 5129.

For the Bijah,				Table XI,	Ψ .	Σ .	Δ .	α .	β .	γ .
Table XII.					5000	-	421	0	18	30
5000	5'	30'		"	100	-	8	5	5	10
100		4		"	20	-	1	8	7	2
20		0	48	"	9	-	0	3	9	54
9			21 36		5129	-	432	5	5	41
								3	23	9
<hr/>										
3	25	9	36							

which shows that on the last day of the Solar year 5129 the Epoch has passed by 16' 44' 24" of Ψ 's motion, which converted into Solar time by Table XIII, give

	Ψ .	Σ .	Δ .	α .	β .	γ .
10'	-	2	0	20	41,5791	
6	-	1	12	12	24,0474	
40'	-		8	1	22,7719	
4	-			48	8,2772	
20"	-			4	0,6897	
4	-				48,1880	
Ψ .		3	21	27	26,4033	
5129	-	303	15	21	31	
5129	-	301	54	4	4,6907	

Epoch of Cahaya when Ψ 's Longitude is precisely (432) 54 . . . A. Caliyugam

For Ψ 's years $432 \times 12 + 5 = 5189$ years. Hence $5189 - 5129 = 60$, which shows that in 5129 Solar Sydercal years, there is a whole cycle or 60 Ψ 's years expunged according to Astro-nomical computation.

EXAMPLE III.

To find the cycles and years of Jupiter, the natural days, guddias, viguddias, &c. elapsed of that account on the birth of Christ.

	By Table XI,	3000	-	232	11	5	0	0
		100	-	8	5	5	10	0
For the Bijah,		1	-	1	1	0	21	6
Table XII.		3101	-	261	5	10	31	6
		Bijah Sodium	-		2	4	2	24
3000	-	2' 0' 0"			261	5	8	27 3 36
100	-	4 0			X 12			
1	-	2 24			3132			
Sodium	2	4 2 24			+ 6			
						Ψ .		
					60)3138(52	18	the years of the	
					138		der to be counted	
							from Vijaya the 27th	
					Remainder 18		inclusive.	

The year sought will be the 44th called *Sadhakana*. For the time due to the degrees above complete signs.

By Table XIII the degrees, &c. being $8^{\circ} 27' 3'' 20''$.

	D.	C.	V.	F.
8°	12	16	33	15,7934
$20'$	4	0	41	23,1331
$7''$	1	24	14	20,1033
$20''$			30	0,2079
$6'''$			0	1,0316
			1	12,5070

The whole time expired is therefore 3137 years of Jupiter + 101 42 12 27,2083

that it is not necessary to refer to the birth of Christ to find the *Vaihaspati* year corresponding to any proposed year since that epoch, and when the name and rank of the *Chakra* year only are wanted, the Rule is confined to a common addition and division.

RULE.

" If the Christian year be proposed, find the corresponding one of the *Calli* yug by adding 3101 thereto, the sum will be the last expired year of the same."

" Divide the expired years of the *Calli* yug by 60; add the quotient to the dividend: divide again the sum by 60, the quotient will give the number of cycles expired; and to the remainder, if the proposed year should fall less than 31 from the last expunged year of the *Chakra* (found in Table XVIII) add 25; but if it falls in the 31 remaining years of a cycle of 60 years, add 27 years, and the remainder so increased, will indicate the numeral of the current year of the *Chakra*, and consequently its appropriate name."

EXAMPLE I.

Let the rank and name of the *Chakra* year which corresponds with A. D. 1822, be required.

	1822	
	+ 3101	
	4923	
By Table XVIII		80)4923(57
the last expunged		87
year fell on A. C.		
4871	4871	60)1080(23
		180
		0
Difference 52		+ 27
therefore 27 are to be added.		27

which increased remainder, indicates at once *Vijaya*, the 27th year of the *Chakra*, as the current one.

EXAMPLE II.

Let the same be wanted for A. D. 1931.

	1931	
	+ 3101	
	5032	
By Table XVIII		80)5032(58
the last expunged		58
year fell on A. C.		
5042	5042	60)5110(25
		310
		10
Difference 10		+ 28
which difference (being less than 31) indicates that 28		58
are to be added to the remainder after division by 60.		

The increased remainder indicates at once *Criminal*, the 28th year of the Cycle, as the current one.

TABLE XIX.

Exhibiting the Epochs of the expunged years of the Cycle of 60 years, agreeably to the Jyau-tistava, compared with those of the Surrish Siddhanta from the birth of Salivahana.

Periods from the Cali yug.	Intervals.	Years of the Cali yug.			Years from the birth of Salivahana.				Intervals.	Periods from the birth of Salivahana.	Epochs in Christian years ac- cording to the Jyau- tistava.
		Surrish Siddhanta	Diff.	Jyau-tis- tava.	Epochs according to the Jyau- tistava.						
					y.	n.	p.	r.			
38	y.	3237	+2	3239	60	363	42	0,87662	y.	1	138
39	86	3223	1	3224	145	364	40	27,35903	86*	2	223
40	80	3409	1	3410	* 231	361	21	45,31653	86*	3	309
41	80	3495	0	3495	316	362	20	11,80904	85	4	394
42	80	3581	-1	3580	401	363	18	38,28330	85	5	479
43	80	3667	2	3665	486	364	17	4,70668	85	6	564
44	80	3753	3	3750	* 571	0	0	0,0	85	7	649
45	86	3839	3	3836	657	361	56	49,20669	86*	8	735
46	86	3925	4	3921	742	362	53	15,68091	86*	9	820
47	86	4011	5	4006	827	363	53	42,17323	85	10	905
48	86	4097	6	4091	912	364	52	8,65650	85	11	990
49	80	4183	6	4177	* 998	361	32	20,61318	86*	12	1076
50	80	4269	7	4262	1083	362	31	83,09650	85	13	1161
51	86	4355	8	4347	1168	363	30	19,57982	85	14	1246
52	86	4441	9	4432	1253	364	28	46,03614	85	15	1331
53	86	4527	9	4518	* 1339	361	10	4,02006	86*	16	1417
54	80	4613	10	4603	1424	362	8	30,60338	85	17	1502
55	80	4699	11	4688	1509	363	6	56,98670	85	18	1587
56	86	4785	12	4773	1594	364	5	23,47002	85	19	1672
57	86	4871	13	4858	1679	365	3	40,95325	85	20	1757
58	86	4957	13	4944	* 1765	361	45	7,90993	86*	21	1843
59	*85	5042	13	5029	1850	362	43	34,39327	85	22	1928
60	86	5128	14	5104	1935	363	42	0,87667	85	23	2013

TABLE XX.

Of the Sun's mean motion for days.

Days.	Sun's mean motion.					Days.	Sun's mean motion.				
	d.	°	'	"	'''		d.	°	'	"	'''
1	0	0	59	8	10	1000	8	25	36	9	33
2	0	1	58	16	20	2000	5	21	12	19	7
3	0	2	57	24	31	3000	2	16	48	28	40
4	0	3	56	32	41	4000	11	12	24	36	14
5	0	4	55	40	51	5000	8	8	0	47	47
6	0	5	54	49	1	6000	5	3	36	57	20
7	0	6	53	57	11	7000	1	29	13	6	54
8	0	7	53	6	21	8000	10	24	49	16	27
9	0	8	52	13	32	9000	7	20	23	25	1
10	0	9	51	21	42	10000	4	16	1	35	34
20	0	19	43	43	23	20000	9	2	3	11	8
30	0	29	31	5	5	30000	1	18	4	45	42
40	1	9	23	26	47	40000	6	4	6	22	10
50	1	19	16	48	29	50000	10	20	7	57	50
60	1	29	8	10	10	60000	3	6	2	33	23
70	2	8	59	31	52	70000	7	22	11	9	57
80	2	18	50	53	34	80000	0	8	12	44	31
90	2	28	42	15	16	90000	4	24	14	20	5
100	3	8	33	36	57	100000	9	10	15	53	39
200	6	17	7	13	55	200000	6	20	51	51	18
300	9	25	40	50	52	300000	4	0	47	46	37
400	1	4	14	27	49	400000	1	11	5	42	36
500	4	12	48	4	47	500000	10	21	19	38	16
600	7	21	21	41	44	600000	8	1	35	33	55
700	10	29	55	18	41	700000	5	11	51	29	34
800	2	8	23	55	39	800000	2	22	7	25	13
900	5	17	2	32	36	900000	0	2	23	40	52
1000	8	25	36	0	33	1000000	9	12	30	16	31

Sun's Drums 11° 25' 25" 34° 23" A. Call yugam 4399 complete.

Generally, for all the Tables contained in this collection where a *Drum* is given, if you compute the number of natural or *Savan* days elapsed from the end of the year for which the *Drum* is given, and add to its Longitude, the Sun, or Planet's motion due to the said number of days, you will have their mean place in the Hindu Zodiac for the proposed day, at mean midnight under the Meridian of Lanka.

TABLE XXI.

Of the mean motion of the Moon, of her Apogee, with Bijah and Nade : The Bijah being common to both the latter ; but as the Nade is taken to move in antecedenat, its Bijah is subtracted.

Days.	Mean.			Apogee.			Bijah.			Nado.		
	s.	'	"	s.	'	"	s.	'	"	s.	'	"
1	0	13	10	34	52		0	0	0	0	0	0
2	0	26	21	9	44		0	0	0	0	0	0
3	1	9	31	44	30		0	0	0	0	0	0
4	1	22	42	19	28		0	0	0	0	0	0
5	2	5	52	54	20		0	0	0	0	0	0
6	2	19	3	29	12		0	0	0	0	0	0
7	3	2	14	4	4		0	0	0	0	0	0
8	3	15	24	28	56		0	0	0	0	0	0
9	3	28	35	12	49		0	0	0	0	0	0
10	4	11	45	48	41		0	0	0	0	0	0
20	8	23	31	37	21		0	0	0	0	0	0
30	1	5	17	26	2		0	0	0	0	0	0
40	8	17	3	14	43		0	0	0	0	0	0
50	9	28	49	3	23		0	0	0	0	0	0
60	2	10	34	52	4		0	0	0	0	0	0
70	0	22	20	40	44		0	0	0	0	0	0
80	11	4	6	29	25		0	0	0	0	0	0
90	3	15	52	18	0		0	0	0	0	0	0
100	7	27	28	6	47		0	0	0	0	0	0

The same continued.

Days.	Moon.			Apogee.			Bijah.			Node.		
	s.	°	'	s.	°	'	°	'	'''	°	'	°
100	7	27	38	0	47		0	0	17	45	0	10
200	3	25	16	13	33		0	0	35	30	0	10
300	11	22	54	20	19		0	0	53	15	0	15
400	7	20	34	27	5		0	1	11	31	0	21
500	3	18	10	33	52		0	1	28	40	0	26
600	11	15	48	40	38		0	1	46	31	1	1
700	7	13	26	47	25		0	2	4	16	1	7
800	3	11	4	54	11		0	2	22	1	1	12
900	11	8	43	0	55		0	2	39	46	1	17
1000	7	6	21	7	42		0	2	57	31	1	22
2000	2	12	42	15	30		0	5	55	3	3	13
3000	9	19	3	23	15		0	8	52	34	5	8
4000	4	25	24	30	53		0	11	50	6	7	1
5000	0	1	43	33	40		0	14	47	37	8	24
6000	7	2	6	46	21		0	17	45	9	10	17
7000	2	14	27	52	6		0	20	43	40	0	10
8000	9	20	49	1	42		0	23	41	11	2	3
9000	4	27	10	0	33		0	26	37	43	3	20
10000	0	3	31	17	16		0	29	35	14	5	19
20000	0	7	2	34	33		0	60	10	20	11	9
30000	0	10	33	51	40		1	28	43	43	4	29
40000	0	14	5	9	6		1	58	20	57	10	19
50000	0	17	26	26	22		2	28	6	12	4	9
60000	0	21	7	43	39		2	57	31	26	0	20
70000	0	24	59	0	55		3	27	6	40	3	18

The same continued.

Days.	Moon.			Apogee.			Eclips.			Node.		
	h.	m.	s.	h.	m.	s.	h.	m.	s.	h.	m.	s.
70000	0	24	59	0	55		7	26	48	13	25	
80000	0	23	10	18	12		9	0	37	63	11	
90000	1	1	41	26	28		10	4	27	42	57	
100000	1	5	12	32	42		11	8	17	27	44	
200000	2	10	25	45	30		10	10	34	55	28	
300000	3	15	38	38	14		9	25	52	23	13	
400000	4	20	51	30	59		9	3	9	50	50	
500000	5	26	4	23	44		8	11	27	13	39	
600000	7	1	17	16	29		7	10	44	40	23	
700000	8	6	30	9	24		6	28	2	14	7	
800000	9	11	43	1	59		6	6	10	41	51	
900000	10	16	55	54	43		5	14	37	9	35	
1000000	11	22	8	47	30		4	22	54	37	19	

Drains. | 11 5 48 37 29 | 4 15 20 17 0 | 1 29 0 54 | 0 6 12 6 0 A. Calf
yug 4500 complete.

TABLE XXII.

Of the Sun's Anomalous Equation.

N. B.—To find the Argument of this Table, subtract the Sun's mean place from that of his Apogee for the time given.

Supplement mean Anomaly.												
°		+ ♄ - VI			+ ♄ - VII			+ ♄ - VIII			°	
°	'	°	'	"	°	'	"	°	'	"	°	'
0	0	0	0	0	1	6	3	1	53	55	30	0
3	45	0	8	64	1	13	18	1	57	22	28	15
7	30	0	17	24	1	20	13	2	0	50	22	30
11	15	0	25	38	1	26	37	2	3	46	18	45
15	0	0	34	24	1	32	57	2	6	11	15	0
18	45	0	42	35	1	38	44	2	8	4	11	15
22	30	0	50	40	1	44	5	2	9	26	7	30
26	15	0	58	22	1	48	59	2	10	15	3	45
30	0	1	0	3	1	53	20	2	10	31	0	0
°		- XI + V			- X + IV			- IX + III			°	
Supplement mean Anomaly.												

TABLE XXIII.

Of the Moon's Anomalistic Equation.

N. B.—To find the Argument, subtract the Moon's mean place from that of her Apogee.

Supplement mean Anomaly.												
		+ III — VI			+ IV — VII			+ V — VIII				
		°	'	"	°	'	"	°	'	"	°	'
0	0	0	0	0	0	32	0	4	22	30	20	0
3	45	0	13	59	3	48	43	4	21	40	26	15
7	30	0	29	52	7	3	52	4	39	56	22	30
11	15	0	59	31	11	20	8	4	49	30	18	45
15	0	1	29	54	15	34	30	4	59	22	15	0
19	45	1	57	51	19	48	1	4	55	59	11	15
23	30	1	56	25	23	0	33	5	0	18	7	30
26	15	2	14	29	26	12	3	5	2	9	3	45
30	0	2	32	0	30	22	30	5	2	46	0	0
		— XI + V			— XII + IV			— I + III				
Supplement mean Anomaly.												

TABLE XXIV.
OF MARISCANDA.*Solar Equations.**Rasi Pāla.*

Extracted from Mr. Davis' Paper on the Astronomical Computations of the Hindus.

Astrol. Res., Vol. II, page 253.

ARGUMENT, THE SUN'S ANOMALY.

Anomaly.	Equation of the mean to the true place.	Equation of the mean to the true motion.	Anomaly.	Equation of the mean to the true place.	Equation of the mean to the true motion.	Anomaly.	Equation of the mean to the true place.	Equation of the mean to the true motion.
1	2 30	2 18	31	1 8 —	1 53	61	1 54 30	1 4
2	4 40	2 18	32	1 9 57	1 53	62	1 55 34	1 0
3	7 —	2 18	33	1 11 57	1 53	63	1 56 35	58
4	9 19	2 17	34	1 13 47	1 51	64	1 57 34	57
5	11 37	2 17	35	1 15 40	1 51	65	1 58 34	55
6	13 55	2 17	36	1 17 32	1 49	66	1 59 30	53
7	16 15	2 16	37	1 19 23	1 47	67	2 — 23	52
8	18 33	2 16	38	1 21 11	1 45	68	2 1 14	49
9	20 51	2 15	39	1 22 57	1 43	69	2 2 4	48
10	23 7	2 14	40	1 24 42	1 42	70	2 2 51	43
11	25 23	2 14	41	1 26 23	1 40	71	2 3 33	41
12	27 39	2 13	42	1 28 7	1 38	72	2 4 17	39
13	29 55	2 13	43	1 29 45	1 36	73	2 4 57	37
14	32 10	2 12	44	1 31 23	1 34	74	2 5 35	35
15	34 31	2 11	45	1 33 58	1 32	75	2 6 12	32
16	36 57	2 11	46	1 34 32	1 30	76	2 6 43	31
17	39 29	2 10	47	1 36 4	1 29	77	2 7 17	28
18	41 1	2 9	48	1 37 35	1 28	78	2 7 45	25
19	43 13	2 8	49	1 39 6	1 26	79	2 8 12	23
20	45 23	2 7	50	1 40 36	1 25	80	2 8 35	22
21	47 51	2 6	51	1 42 3	1 23	81	2 8 58	20
22	49 39	2 6	52	1 43 26	1 19	82	2 9 18	18
23	51 47	2 5	53	1 44 45	1 16	83	2 9 59	15
24	53 53	2 3	54	1 45 2	1 14	84	2 9 51	12
25	55 57	2 2	55	1 47 17	1 13	85	2 10 3	10
26	58 1	2 1	56	1 48 33	1 13	86	2 10 13	8
27	1 — 9	2 —	57	1 49 47	1 12	87	2 10 20	6
28	1 2 53	1 55	58	1 51 —	1 11	88	2 10 27	4
29	1 4 3	1 57	59	1 52 12	1 11	89	2 10 31	1
30	1 6 9	1 56	60	1 53 25	1 8	90	2 10 32	0

These, and preceding Tables, were constructed for the same end. The present are adapted to Mariscanda's Rules: the former to Vavilala Cochina's, with a different Argument. Attention is to be paid when using Mariscanda's, whether the Equation be additive or subtractive. Vavilala's leave no doubt on the subject, but they do not exhibit the Equation from mean to true motion; though the same may be worked by their means.

TABLE XXV.

*Lunar Equations.**Chandra Pāda.*

Vide Notes preceding Table.

ARGUMENT, THE MOON'S ANOMALY.

Anomaly.	Equation of the mean to the true place.		Equation of the mean to the true motion.	Anomaly.	Equation of the mean to the true place.		Equation of the mean to the true motion.	Anomaly.	Equation of the mean to the true place.		Equation of the mean to the true motion.
1	5	20	69 50	31	2	36 37	69 20	61	4	25 26	33 41
2	10	40	69 56	32	2	41 11	58 41	62	4	27 36	32 39
3	16	—	69 33	33	2	45 26	54 —	63	4	29 39	31 35
4	21	19	69 28	34	2	49 58	57 12	64	4	32 19	30 29
5	26	36	69 21	35	2	54 20	56 37	65	4	34 37	29 22
6	31	54	69 17	36	2	58 39	55 36	66	4	36 47	28 17
7	37	12	69 4	37	3	2 54	55 14	67	4	38 54	27 7
8	42	29	68 54	38	3	7 5	54 30	68	4	40 54	25 1
9	47	44	68 43	39	3	11 12	53 41	69	4	42 30	24 55
10	52	58	68 28	40	3	15 16	52 58	70	4	44 40	23 40
11	58	11	68 11	41	3	19 18	51 26	71	4	46 24	22 42
12	1	3 23	67 52	42	3	23 24	50 57	72	4	48 5	21 34
13	1	8 40	67 35	43	3	27 26	50 48	73	4	49 38	20 24
14	1	13 45	67 17	44	3	30 54	49 46	74	4	51 0	19 14
15	1	18 55	66 55	45	3	34 39	48 54	75	4	52 53	18 3
16	1	24 —	66 36	46	3	38 21	48 —	76	4	54 54	16 51
17	1	29 3	66 16	47	3	41 58	47 5	77	4	56 6	15 38
18	1	34 9	65 57	48	3	45 32	46 0	78	4	56 15	14 25
19	1	39 10	65 30	49	3	48 59	45 13	79	4	57 17	13 14
20	1	44 9	65 14	50	3	52 24	44 19	80	4	58 13	12 3
21	1	49 17	64 50	51	3	55 46	43 27	81	4	59 6	10 53
22	1	54 3	64 24	52	3	59 2	42 32	82	4	59 53	9 41
23	1	59 3	63 56	53	4	2 13	41 37	83	5	— 27	8 34
24	2	3 47	63 24	54	4	5 18	40 41	84	5	1 8	7 14
25	2	8 23	62 53	55	4	8 18	39 44	85	5	1 40	6 2
26	2	13 22	62 21	56	4	11 16	38 47	86	5	2 3	4 51
27	2	18 6	61 48	57	4	14 11	37 50	87	5	2 20	3 40
28	2	22 47	61 13	58	4	17 —	36 51	88	5	2 36	2 27
29	2	27 35	60 35	59	4	19 46	35 48	89	5	2 44	1 44
30	2	32 2	59 56	60	4	22 29	34 48	90	5	2 49	— —

TABLE XXVL

Being the first of the Vakiam process.

This Table gives the Drava of the Moon's true place and her true motion for every day in a Devaram, or 248. days. Communicated by Andy Sashya Nootra.

Days.	Moon's <i>Pāla</i>			P's true motion in one day.	Days.	Moon's <i>Pāla</i>			P's true motion in one day.	Days.	Moon's <i>Pāla</i>			P's true motion in one day.
1	0	12	5	723	55	3	19	59	807	71	7	7	51	855
2	0	21	9	725	57	4	3	21	823	72	7	21	58	847
3	1	6	23	733	58	4	17	15	834	73	9	3	55	837
4	1	16	41	742	59	5	1	20	845	74	8	19	40	825
5	2	1	19	753	40	5	15	23	855	75	9	3	10	819
6	2	14	9	770	41	5	29	51	868	76	9	15	25	799
7	2	27	13	784	42	6	14	19	880	77	9	29	21	779
8	3	10	33	800	43	6	23	27	897	78	10	12	8	764
9	3	21	9	816	44	7	12	37	910	79	10	21	39	751
10	4	7	58	829	45	7	26	39	922	80	11	6	58	735
11	4	21	58	840	46	8	10	30	934	81	11	19	8	720
12	5	8	8	850	47	8	24	7	947	82	0	1	13	725
13	5	20	25	857	48	9	7	29	960	83	0	13	15	719
14	6	4	44	869	49	9	20	35	976	84	0	25	19	724
15	6	19	2	888	50	10	3	25	991	85	1	7	27	728
16	7	3	15	853	51	10	16	2	756	86	1	19	43	736
17	7	17	22	847	52	10	23	26	744	87	2	3	10	747
18	8	1	17	835	53	11	10	40	734	88	2	14	49	750
19	8	15	1	824	54	11	22	46	736	89	2	27	43	774
20	8	28	20	808	55	0	4	49	723	90	3	19	53	760
21	9	11	42	793	56	0	16	52	723	91	3	24	19	803
22	9	24	40	778	57	0	28	42	725	92	4	7	58	810
23	10	7	23	763	58	1	11	10	732	93	4	21	52	834
24	10	19	52	749	59	1	23	31	741	94	5	6	56	844
25	11	2	10	738	60	2	6	3	734	95	5	20	8	852
26	11	14	19	729	61	2	18	24	707	96	6	4	26	858
27	11	20	24	703	62	3	1	25	763	97	6	18	45	859
28	0	8	20	742	63	3	15	14	790	98	7	3	9	857
29	0	20	30	734	64	3	28	47	813	99	7	17	13	851
30	1	2	38	728	65	4	12	35	828	100	8	1	17	844
31	1	14	23	737	66	4	26	34	839	101	8	13	8	921
32	1	27	23	748	67	5	10	41	850	102	8	28	47	819
33	2	10	4	761	68	5	24	59	855	103	9	12	10	803
34	2	23	0	776	69	6	9	17	858	104	9	25	18	798
35	3	6	12	792	70	6	23	26	859	105	10	8	11	773

Days.	Moon's P^h h^m s			P 's true motion in one day.	Days.	Moon's P^h h^m s			P 's true motion in one day.	Days.	Moon's P^h h^m s			P 's true motion in one day.
100	10	20	48	737	150	8	5	52	814	204	5	15	7	842
107	11	3	14	740	156	8	19	49	834	205	5	29	17	849
108	11	13	28	730	157	9	3	20	830	206	5	13	34	857
109	11	27	30	729	165	9	16	51	835	207	5	27	53	859
110	0	9	39	723	159	10	0	1	790	208	7	12	11	858
111	0	21	41	722	160	10	12	35	774	209	7	26	24	858
112	1	3	46	725	161	10	23	34	759	210	8	10	20	845
113	1	15	53	722	162	11	8	1	747	211	8	23	23	834
114	1	22	18	740	163	11	20	17	736	212	9	8	5	822
115	2	10	50	752	164	0	2	25	728	213	9	21	32	807
116	2	23	36	766	165	0	11	20	724	214	10	4	43	792
117	3	6	37	781	166	0	25	31	722	215	10	17	49	776
118	3	19	54	797	167	1	8	35	725	216	11	0	21	761
119	4	3	50	812	168	1	20	46	730	217	11	12	49	748
120	4	17	19	826	169	2	3	5	739	218	11	25	6	737
121	5	1	14	839	170	2	15	38	751	219	0	7	14	728
122	5	15	19	848	171	2	28	29	764	220	0	19	18	721
123	5	29	34	855	172	3	11	19	779	221	1	1	20	722
124	6	13	52	858	173	3	24	34	795	222	1	13	29	725
125	6	23	10	858	174	4	8	4	810	223	1	25	34	729
126	7	12	25	855	175	4	21	49	825	224	2	7	52	738
127	7	26	33	848	176	5	5	45	837	225	2	20	51	749
128	8	10	32	839	177	5	19	53	847	226	3	3	4	763
129	8	24	18	820	178	6	4	8	855	227	3	16	2	772
130	9	7	50	812	179	6	18	27	859	228	3	29	15	793
131	9	31	7	797	180	7	2	45	858	229	4	12	43	809
132	10	4	8	781	181	7	17	0	855	230	4	26	27	814
133	10	16	54	766	182	8	1	10	850	231	5	10	23	825
134	10	29	29	752	183	8	15	0	831	232	5	23	29	837
135	11	11	40	740	184	8	28	57	823	233	6	5	42	853
136	11	23	38	732	185	9	12	30	813	234	6	23	0	855
137	0	6	3	725	186	9	25	49	799	235	7	7	19	859
138	0	18	6	724	187	10	8	52	783	236	7	21	36	857
139	1	0	8	723	188	10	21	39	767	237	8	5	46	850
140	1	12	10	728	189	11	4	13	754	238	8	19	46	840
141	1	24	30	724	190	11	16	34	741	239	9	3	35	829
142	2	6	56	746	191	11	28	46	729	240	9	17	11	816
143	2	18	22	757	192	0	10	52	725	241	10	0	31	801
144	3	2	35	773	193	0	22	55	723	242	10	13	36	781
145	3	15	34	788	194	1	4	58	722	243	10	26	25	770
146	4	28	57	803	195	1	17	4	725	244	11	0	0	755
147	4	12	36	819	196	1	29	13	734	245	11	21	22	742
148	4	26	27	831	197	2	11	42	744	246	0	3	35	733
149	5	10	31	844	198	2	24	18	756	247	0	15	41	725
150	5	24	42	851	199	3	7	0	771	248	0	27	44	723
151	6	5	50	857	200	3	20	15	786					
152	6	23	18	850	201	4	3	37	802					
153	7	7	38	838	202	4	17	14	817					
154	7	21	43	852	203	5	1	5	831					

TABLE XXVII, Part I.

Being the second used in the *Vakiam*, or *Solar process*, and called by the *Tamil Astronomers* the *Voghiadi Table*, &c.

	Solar months.	Dates.	Equat. on for 8 days in calas.			Solar months.	Dates.	Equat. on for 8 days in calas.	
1 Υ	Chaitram. — or Vaishāṣa.	1 9 17 25	11 14 16 17	0	7 Δ	Āṣvini. + or Kartika.	1 9 17 25	1 2 3 5	6
2 Ο	Vyāṣaḥi. — or Jāṣṭhā.	1 9 17 25	10 21 22 24	1	8 Π	Kāṣṭhā. + or Mārgaśīṣa.	1 9 17 25	0 8 9 10	7
3 Π	Āṣvini. — or Āśvīnāḥi.	1 9 17 25	24 25 25 24	2	9 I	Mārgaḥi. + or Pauṣa.	1 9 17 25	10 11 11 11	8
4 Ξ	Āṣvini. — or Śrāvaṇa.	1 9 17 25	24 23 22 21	3	10 Υ	Tyā. + or Māgha.	1 9 17 25	11 9 8 7	9
5 Ξ	Āṣvini. — or Bhāḍṛa.	1 9 17 25	10 17 13 13	4	11 =	Māṣā. + or Phālguna.	1 9 17 25	0 4 2 0	10
6 Ξ	Parāṣā. — or Āṣvini.	1 9 17 25	11 8 6 3	5	12 Ξ	Phālguna. — or Chitra.	1 9 17 25	2 4 7 10	11

How to find by this Table the Equation due to any proposed day.

1^o Convert the number of months and days elapsed since the origin Chaitram, the former into their respective signs, the latter into degrees.

2^o If the month began in the day (after Sun rise) deduct the guddias as calas, which are wanting to complete the day on which the month began, whatever be the date in the said month for which you work. And if it commenced during the night, add the same. Or if during day, then subtract 1 degree; and add the complement of initial root to 60 guddias converted into calas.

3^o To find the Equation for one day. Divide the Equation given in the Table by 8; and either add or subtract the quotient, as the given month may require. That is, add from the beginning of Āṣvini to the end of Māṣā; and subtract from the beginning of Phālguna to the end of Parāṣā. Multiply the Equation for one day by the number of days you require in the interval of 8 days; the product is the Equation required. The calas registered in the 4th column, are the sum of the Equations for 8 days given in advance. Thus 11 calas found opposite to 1st Chaitram, show that on the 8th day of that month, 11 calas will be due.

TABLE XXVII, Part 2.

Containing the Arguments of the Sun's Anomalous Equation for the first day of every month in the year; and for finding the same, add his true diurnal motion for every day in each month by Table XXII or XXIV.

Month by the Sun and Moon																																																													
Sign.	Current.	Complete.	Type.	Tamil names, Solar months.	Bengal names, Solar months.	Quadrant of Anomaly.	Place of the Sun on the 1st of each month, relatively to his Apogee or Perigee.	☉'s Equation. \pm	☉'s true diurnal motion \pm than his mean, or 59' 8".																																																				
							<table><tr><td>1.</td><td>2.</td><td>3.</td><td>4.</td></tr><tr><td>2</td><td>17</td><td>17</td><td>20</td></tr><tr><td>1</td><td>17</td><td>17</td><td>20</td></tr><tr><td>0</td><td>17</td><td>17</td><td>20</td></tr><tr><td>0</td><td>12</td><td>42</td><td>40</td></tr><tr><td>1</td><td>12</td><td>42</td><td>40</td></tr><tr><td>2</td><td>12</td><td>42</td><td>40</td></tr><tr><td>2</td><td>17</td><td>17</td><td>20</td></tr><tr><td>1</td><td>17</td><td>17</td><td>20</td></tr><tr><td>0</td><td>17</td><td>17</td><td>20</td></tr><tr><td>0</td><td>12</td><td>42</td><td>40</td></tr><tr><td>1</td><td>12</td><td>42</td><td>40</td></tr><tr><td>2</td><td>12</td><td>42</td><td>40</td></tr></table>	1.	2.	3.	4.	2	17	17	20	1	17	17	20	0	17	17	20	0	12	42	40	1	12	42	40	2	12	42	40	2	17	17	20	1	17	17	20	0	17	17	20	0	12	42	40	1	12	42	40	2	12	42	40		
1.	2.	3.	4.																																																										
2	17	17	20																																																										
1	17	17	20																																																										
0	17	17	20																																																										
0	12	42	40																																																										
1	12	42	40																																																										
2	12	42	40																																																										
2	17	17	20																																																										
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0	17	17	20																																																										
0	12	42	40																																																										
1	12	42	40																																																										
2	12	42	40																																																										
1	15	Y	Cheltram	Voitacha	IV		Supplement of	+	—																																																				
2	1	8	Vyasaai	Jaishta			Anomaly to	+	—																																																				
3	2	II	Auni	Ashadha			300'	+	18th Minimum.																																																				
4	3	III	Audi	Shravana				—	—																																																				
5	4	Q	Anani	Bhadra	I		Anomaly.	—	—																																																				
6	5	Q	Pazhani	Asvina				—	18th 1st Mean.																																																				
7	6	Q	Arpasi	Cartika				—	+																																																				
8	7	III	Carilga	Margashira				—	+																																																				
9	8	2	Margali	Pamshir	II		Distance from	—	+																																																				
10	9	2	Tye	Magha			Perigee.	—	+																																																				
11	10	2	Mumai	Phalgun				+	+																																																				
12	11	2	Poongoni	Chitra				+	18th 2d Mean.																																																				

Explanation and use of the 2d Part.

This second part of Table XXVII was constructed for the purpose of finding the Sun's Anomalous Equation, his true diurnal motion, his Arca Bhagabala, and that of the Moon, for any day in the year; which the first only supplies in part.

The quantities registered in the 5th column are the Arguments of the Sun's Equation for the first day of every month, to be used either with Table XXII (of Varilala Cuchinna) or XXIV (of Narayana).

The positive and negative Signs proper to the Equation sought, are to be taken as given in the 6th column and not as in the Tables referred to, observing that they pass from + to — on or near the 15th of Auni; and from — to + about the 18th Margali, for the reasons given in the second Part of the Key to the Siddhanta Chandra Mana; Article 2, page 127. (*)

(*) E. G. Take Argument in Auni — 1 12 42 40 Anomaly.
19

Supplement Anomaly — 11 17 17 20 Argument Table XXII.

Equation subtracted.
Eq. 1st Mean — 1 12 42 40 dist. from Perigee +
Add 8

Anomaly — 1 12 42 40
19

Supplement Anomaly — 4 17 17 20 Argument Table XXII.

Equation additive.

For obtaining the Sun's Equation and diurnal motion on the intermediate days of each month, his mean motion for days (as given in Table XX) is to be applied \pm to the Argument of the first day as it goes on increasing or decreasing in that particular Quadrant of Anomaly.

The positive and negative Signs registered in the 7th column, indicate whether the Sun's true be greater or less than his mean diurnal motion, or $30' 8''$. And the Equation referring thereto in Tables XXII or XXIV (to be obtained by the same Argument) are to be used accordingly, without any regard to the Signs exhibited in these Tables.

The whole of the second part of Table XXVII is computed for the beginning of the 4041st Solar year of the Cali yug (11th April A. D. 1839) when the Sun's Apogee, according to Hindu theory, will lie in $2^{\circ} 17' 17'' 20''$ from the beginning of the Solar Syderal Zodiac; but it may be adapted to any position of the Sun's Apis, as follows:

As the Apogee is supposed to move at the rate of $1'$ in 217 years, its distance from the first point in Mesha γ will be $2^{\circ} 17' 17'' 20'' + 1'$ in the year 4040 $+ 517$ complete, for the same reason that it was $2^{\circ} 17' 17'' 20'' - 1'$ in the year 4040 $- 517$. That and all other Arguments are therefore to be rectified on the same scale by a rule of proportion.

But as in the 6th column, the \odot 's place is given relatively to his Apogee and Perigee, the increment so obtained is to be added in the 4th and 2d; and subtracted in the 1st and 3d Quadrants of Anomaly, and the contrary if it be a decrement, or for anterior times.

EXAMPLE.

Let the Sun's Equation, true diurnal motion, and Arca Bhagábala, as well as that of the Moon, be required for the 15th Chaitram complete of the 4041st year of the Cali yug current.

Argument of Equation, 1st Chaitram, Table XXVII, part 2	-	2 17 17 20
Subtract \odot 's mean motion for 15 days, Table XX	-	14 47 3
Manda Kendra, 15th Chaitram	-	2 2 30 17
		or 62 50 17

with which Argument, referring to Maracanda's Table (XXIV) we find the Sun's Anomalistic Equation $1^{\circ} 56' 4''$, which is positive on account of the sign $+$ in the 6th column of the present Table, and according to the well known precept the Solar Arca Bhagábala will be $+$ $\frac{1^{\circ} 56' 4''}{203} = + 10''$

$$\text{and the Lunar} \quad - \quad - \quad \frac{1^{\circ} 56' 4''}{27} = + 4' 17''.$$

The Equation of the Sun's true to mean motion, answering to the same Argument in the same Table, is

\odot 's mean motion	-	59 5
Sun's true diurnal motion, 15th Chaitram	-	58 9

N. B.—It is to be understood, however, that both parts of Table XXVII only give approximations, with which the Tamul Astronomers are contented.

TABLE XXVIII.

Of the Sun's true motion for 365 days, (3d of the Faltun). Communicated by R. Aulky Sakhya Brahmata.

Y Vaisākh or Chaitram.	U Jyeshtha or Vysāgi.	II Āshād'hā or Āṣāḍ.	III Śrāvastā or Āṣṭ.	IV Bhādrā or Āṣāḍ.	V Āṣāḍ or Pāṣāṇī.
a. Tr. motion.	a. Tr. motion.	a. Tr. motion.	a. Tr. motion.	a. Tr. motion.	a. Tr. motion.
1 53 40	1 57 38	1 56 59	1 56 53	1 57 27	1 58 25
2 53 38	2 57 36	2 56 58	2 56 50	2 57 29	2 58 23
3 53 36	3 57 35	3 56 57	3 56 57	3 57 31	3 58 20
4 53 34	4 57 34	4 56 56	4 56 58	4 57 33	4 58 18
5 53 31	5 57 32	5 56 55	5 56 59	5 57 35	5 58 14
6 53 29	6 57 31	6 56 54	6 57 0	6 57 36	6 58 10
7 53 25	7 57 29	7 56 54	7 57 1	7 57 38	7 58 08
8 53 23	8 57 27	8 56 53	8 57 2	8 57 39	8 58 04
9 53 21	9 57 25	9 56 53	9 57 3	9 57 41	9 58 02
10 53 19	10 57 24	10 56 52	10 57 4	10 57 43	10 58 00
11 53 17	11 57 22	11 56 52	11 57 5	11 57 45	11 58 00
12 53 15	12 57 21	12 56 52	12 57 6	12 57 46	12 58 00
13 53 12	13 57 20	13 56 52	13 57 7	13 57 48	13 58 00
14 53 10	14 57 19	14 56 51	14 57 8	14 57 50	14 58 00
15 53 8	15 57 17	15 56 51	15 57 9	15 57 52	15 58 00
16 53 7	16 57 16	16 56 51	16 57 10	16 57 54	16 58 00
17 53 6	17 57 15	17 56 50	17 57 11	17 57 56	17 58 00
18 53 3	18 57 13	18 56 50	18 57 12	18 57 58	18 58 00
19 53 1	19 57 12	19 56 50	19 57 13	19 58 0	19 58 00
20 57 53	20 57 11	20 56 50	20 57 14	20 58 2	20 58 00
21 57 50	21 57 10	21 56 50	21 57 15	21 58 4	21 58 00
22 57 51	22 57 9	22 56 50	22 57 16	22 58 6	22 58 00
23 57 52	23 57 7	23 56 51	23 57 17	23 58 8	23 58 00
24 57 50	24 57 6	24 56 51	24 57 18	24 58 10	24 58 00
25 57 48	25 57 4	25 56 51	25 57 19	25 58 12	25 58 00
26 57 46	26 57 3	26 56 52	26 57 20	26 58 14	26 58 00
27 57 45	27 57 2	27 56 52	27 57 21	27 58 16	27 58 00
28 57 43	28 57 1	28 56 52	28 57 22	28 58 18	28 58 00
29 57 41	29 57 0	29 56 53	29 57 23	29 58 20	29 58 00
30 57 40	30 56 59	30 56 54	30 57 24	30 58 22	30 58 00
31 57 38	31 56 59	31 56 54	31 57 25	31 58 24	31 58 00
		Minimum.			Mean.
		32 56 53			32 58 26

This Table answers for the beginning of the year 4924 of the Caliyug (A. D. 1822) when the place of the Sun's Apogee in the Hindu Zodiac was $2^{\circ} 17' 18''$ and its Tropical Longitude (or *Rasi Sayana*) $3^{\circ} 7' 43''$. As the Sun's Apogee is supposed to move only at the rate of $1'$ in 517 years, the Peninsula Astronomers conceive that it answers sufficiently well for many centuries past and to come, for computing the Kalendar.

♂ Cārtiga or Arped.			♂ Ma'ngaf'ras or Cārtiga.			♂ Paathla or Mergali.			♂ Ma'ghr or Tye.			= Pha'lgua or Maazri.			= Cātra or Poungoni.		
n.	Tr. motion.		n.	Tr. motion.		n.	Tr. motion.		n.	Tr. motion.		n.	Tr. motion.		n.	Tr. motion.	
1	59	44	1	60	44	1	61	23	1	61	24	1	60	53	1	59	33
2	59	46	2	60	46	2	61	23	2	61	23	2	60	51	2	59	31
3	59	48	3	60	48	3	61	24	3	61	22	3	60	49	3	59	29
4	59	50	4	60	50	4	61	24	4	61	21	4	60	47	4	59	27
5	59	52	5	60	52	5	61	25	5	61	20	5	60	45	5	59	25
6	59	54	6	60	54	6	61	25	6	61	19	6	60	43	6	59	23
7	59	56	7	60	56	7	61	25	7	61	18	7	60	41	7	59	21
8	59	58	8	60	58	8	61	25	8	61	17	8	60	39	8	59	19
9	60	0	9	61	0	9	61	25	9	61	16	9	60	37	9	59	17
10	60	2	10	61	2	10	61	26	10	61	15	10	60	35	10	59	15
11	60	4	11	61	4	11	61	26	11	61	14	11	60	33	11	59	13
12	60	6	12	61	6	12	61	26	12	61	13	12	60	31	12	59	11
13	60	8	13	61	8	13	61	26	13	61	12	13	60	29	13	59	9
14	60	10	14	61	10	14	61	26	14	61	11	14	60	27	14	59	7
15	60	12	15	61	12	15	61	26	15	61	10	15	60	25	15	59	5
16	60	14	16	61	14	16	61	26	16	61	9	16	60	23	16	59	3
17	60	16	17	61	16	17	61	26	17	61	8	17	60	21	17	59	1
18	60	18	18	61	18	Maximum.		18	61	7	18	60	19	18	59	0	
19	60	20	19	61	20	19	61	26	19	61	6	19	60	17	19	59	0
20	60	22	20	61	22	20	61	26	20	61	5	20	60	15	20	59	0
21	60	24	21	61	24	21	61	26	21	61	4	21	60	13	21	58	50
22	60	26	22	61	26	22	61	26	22	61	3	22	60	11	22	58	57
23	60	28	23	61	28	23	61	26	23	61	2	23	60	9	23	58	54
24	60	30	24	61	30	24	61	26	24	61	1	24	60	7	24	58	51
25	60	32	25	61	32	25	61	26	25	61	0	25	60	5	25	58	48
26	60	34	26	61	34	26	61	25	26	60	59	26	60	3	26	57	47
27	60	36	27	61	36	27	61	25	27	60	58	27	60	1	27	57	45
28	60	38	28	61	38	28	61	25	28	60	56	28	59	59	28	57	43
29	60	40	29	61	40	29	61	25	29	60	55	29	59	57	29	57	41
30	60	42	30	61	42	30	61	25	30	59	53	30	59	55	30	57	40

TABLE XXX.

Trigonometrical Table, to Radius 3438.

Signs.	Periods	0° or VI°			Periods	I° or VII.			Periods	II° or VIII.			Signs.
Degrees.		Sines	Cosines	V. sines.		Sines	Cosines	V. sines.		Sines	Cosines	V. sines.	Deg.
0 0	0	000	3438	0	8	1719	2978	400	16	2978	1719	1719	30 0
3 45	1	225	3431	7	9	1910	2859	579	17	3084	1520	1518	30 1
7 30	2	449	3409	29	10	2023	2728	710	18	3177	1315	1313	31 3
11 15	3	671	3372	60	11	2267	2585	853	19	3256	1105	1103	31 4
15 0	4	890	3321	117	12	2431	2431	1007	20	3321	890	889	31 0
18 45	5	1105	3256	182	13	2585	2267	1171	21	3372	671	670	31 1
22 30	6	1315	3177	261	14	2728	2023	1345	22	3409	449	449	31 30
26 15	7	1520	3084	353	15	2859	1910	1528	23	3421	225	225	3 45
30 0	8	1719	2978	400	16	2978	1719	1719	24	3438	000	3438	0 0
Degrees.	Periods	Sines	Cosines	V. sines.	Periods	Sines	Cosines	V. sines.	Periods	Sines	Cosines	V. sines.	Deg.
		XI° or V.				X° or IV.				IX° or III.			Signs.

Besides the method by continual bisection of an Arc of 30°, and extracting the square root, those who undertake to expound the Sarrish Siddhanta have another Rule for computing the common Table of Sines.

The Prathama Jiz, or Sine of the 1st Pinda is supposed equal to the Arc itself; or Sine of 3° 45' = 225°, the Radius or Sine of 90° being 3438°, and the Cosine of the 1st Pinda, or Cosine 3° 45' = $\sqrt{3438^2 - 225^2} = 3431$.

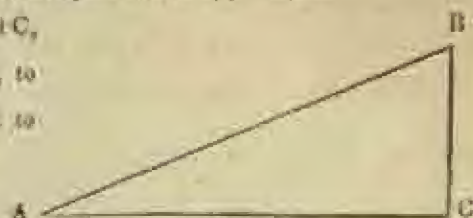
If $A=B$; A , and $A+B$ be three Arcs, whose common difference $B=3^\circ 45'$. Then the Rule for computing the Table of Sines may be expressed in Algebraical characters as follows: Sine $A+B = 2 \text{ Sine } A - \frac{\text{Sine } A}{\text{Sine } B} - \text{Sine } AB$. Thus let $A=B=3^\circ 45'$ or $A+B=7^\circ 30'$. Then Sine $7^\circ 30' = 2 \times 225 - \frac{225}{3438} - \text{Sine } 0^\circ = 450 - 1 = 449$. Next let $A=7^\circ 30'$, $B=3^\circ 45'$, $A+B=11^\circ 15'$; Then Sine $11^\circ 15' = 2 \times 449 - \frac{449}{3438} - 225 = 898 - 2' - 225 = 671$. And so on of the whole Quadrant.

To see the reason of this Rule more clearly, suppose again $A=B$; then Sine $2B = \text{Sine } A+B = 2 \text{ Sine } B - \frac{\text{Sine } B}{\text{Sine } B} - \text{Sine } 0^\circ = 2 \text{ Sine } B - 1$; and if A be now any Arc whatever, then Sine $A+B = 2 \text{ Sine } A - \frac{\text{Sine } A}{\text{Sine } B} - \text{Sine } A-B$, gives Sine $A+B + \text{Sine } A-B = 2 \text{ Sine } A - \frac{\text{Sine } A}{\text{Sine } B} = \text{Sine } A \times \frac{2 \text{ Sine } B - 1}{\text{Sine } B} = \text{Sine } A \times \frac{2 \text{ Sine } B \times \text{Cosine } B}{\text{Sine } B} = 2 \text{ Sine } A \times \text{Cosine } B$.

When the Sines of all the Pindas have been computed, the *Veried Sines* are easily found by subtracting the Sine of the complement from the Radius.

When Sines and Cosines only are required, the Indian Rules of Trigonometry appear very seldom to differ from those used by Europeans. But for solving those cases wherein Europeans make use of Tangents, the Indian Rule must necessarily be different, at least in appearance.

1st Let ABC be a plane Triangle, right angled at C, having an oblique angle at A, and one side given, to find the other side, the common Rule is equivalent to this proportion,



$$\text{Cosine A} : \text{Sine A} :: \text{AC} : \text{CB} \text{ or } \text{Sine A} : \text{Cosine A} :: \text{CB} : \text{AC}.$$

2nd If the hypotenuse be required from the same data, the Indian rule is equivalent to

$$\text{Cosine A} : \text{Radius} :: \text{AC} : \text{AB} \text{ or } \text{Sine A} : \text{Radius} :: \text{BC} : \text{AB}.$$

3rd If the sides be given, to find the oblique angles, they first find the hypotenuse.

$$\text{AB} = \sqrt{\text{AC}^2 + \text{BC}^2}, \text{ and then } \text{AB} : \text{Radius} :: \text{BC} : \text{Sine A} \text{ or } \text{AB} : \text{Radius} :: \text{AC} : \text{Cosine A}.$$

4th If the hypotenuse and a side be given, to find the other side they use $\text{BC} = \sqrt{\text{AB}^2 - \text{AC}^2}$.

5th As every oblique angled triangle is equal to the sum or difference of two right angled triangles, a proposition well known to the Hindus, it may be inferred that they know how to apply Trigonometry to the resolution of oblique angled plane triangles; but of this I have met no example.

There is in the French Ephemerides (*Connaissance des Temps*) for 1808, a curious paper on the Hindu Table of Sines by Mr. Delambre, to which I refer the reader (p. 447). He observes that if in computing the *Mindas* the Hindu divisor $\pi \frac{1}{17}$ be used and the Radius at 3438, only the three first would be correct, after which the error would increase rapidly. But if $\pi \frac{1}{17.7}$ be employed, and Radius 3437, 4 be substituted to the former, then the Hindu results would come (with a few and trifling exceptions) the same as exhibited in the preceding Table and as would result from his formula,

$$\Delta (^{\circ}) \text{Sine A} = - 4 \text{Sine } ^{\circ} \frac{1}{2} \Delta \text{A Sine A} = - \overline{\text{Chord}^2} \times \Delta \text{A} \times \text{Sine A. } (^{\circ}).$$

(Vide Decimal Tables, page 42.)

Mr. D. has recomputed the Hindu Trigonometrical Table on the principle that he proposes, and the only sensible differences fall on

A		Hindu Formula	French Formula
22	30	1312	1315.56
35	15	1520	1520.59
60	0	2078	2077.47
67	30	3177	3176.00

To Radius 3437, 4.

which differences, he observes, are so trifling, that they do not affect his proposition.

(*) ΔA being equal to $4^{\circ} 45'$.

The following Problems of Hindu Spherical Trigonometry will illustrate the various cases of Gnomonics given in Part I, Article 8, page 90 and following of the 2d Mémoire.

A. The modern rules make it appear that the people of India at some former period were well acquainted with the theory of Spherical Trigonometry, if they be not acquainted with it at present.

17. Let $A B C$ be a Spherical Triangle, right angled at C , having an oblique angle at A ; and a side BC given. To find the other side AC .

One of these rules is equivalent to these proportions.

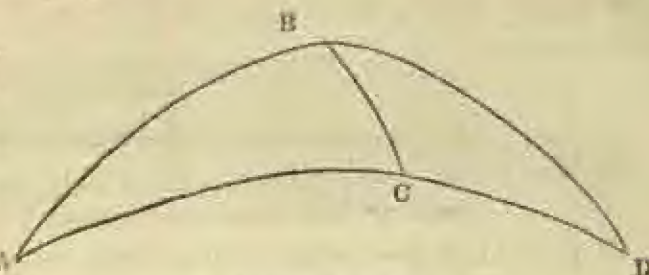
First. $\text{Sine } A : \text{Sine } BC :: \text{Radii}$.

or: $\text{Sine } AB = \frac{\text{Rad} \times \text{Sine } BC}{\text{Sine } A}$; and

Secondly. $\text{Cosine } BC : \text{Cosine}$

$A :: \text{Sine } A B : \text{Sine } A C =$

$\frac{\text{Cos. } A \times \text{Sine } AB}{\text{Cosine } BC} = \frac{\text{Rad.} \times \text{Cos. } A \times \text{Sine } BC}{\text{Sine } A \times \text{Cos. } BC}$.



This answers to the European method; for $\text{Cot. } A = \frac{\text{Radius} \times \text{Cosine } A}{\text{Sine } A}$; and $\text{Tang. } BC = \frac{\text{Radius} \times \text{Sine } BC}{\text{Cosine } BC}$; so that $\text{Sine } AC = \frac{\text{Radius} \times \text{Cosine } A \times \text{Sine } BC}{\text{Sine } A \times \text{Sine } BC} = \frac{\text{Cos. } A \times \text{Tang. } BC}{\text{Radius}}$; which agrees with Napier's Rule.

Another Rule amounts to these proportions, viz.

First. $\text{Sine } A : \text{Cosine } A :: \text{Sine } BC : \text{Sine } Z = \frac{\text{Cosine } A \times \text{Sine } BC}{\text{Sine } A}$; and

Secondly. $\text{Cosine } BC : \text{Radius} :: \text{Sine } Z : \text{Sine } AC = \frac{\text{Radius} \times \text{Sine } Z}{\text{Cosine } BC} = \frac{\text{Radius} \times \text{Cosine } A \times \text{Sine } BC}{\text{Sine } A \times \text{Cosine } BC}$

the same as before.

When BC is a small Arc, and of course $\text{Cosine } BC = \text{Radius}$ nearly, the second proportion is omitted; and $\text{Sine } AC$ taken equal to $\text{Sine } Z = \frac{\text{Cosine } A \times \text{Sine } BC}{\text{Sine } A}$ conformably to the rule in Plane Trigonometry.

20. If the hypotenuse and a side be given, to find the other side, they proceed as follows:

First. $\sqrt{\text{Sine}^2 AB - \text{Sine}^2 BC} = \text{Sine } Z$. Secondly, $\text{Cosine } BC : \text{Radius} :: \text{Sine } Z : \text{Sine}$

$AC = \frac{\text{Radius} \times \text{Sine } Z}{\text{Cosine } BC} = \frac{\text{Radius}}{\text{Cosine } BC} \times \sqrt{\text{Sine}^2 AB - \text{Sine}^2 BC}$.

This is a correct value of $\text{Sine } AC$; for $\text{S.}^2 AB - \text{S.}^2 BC = \text{Cosine}^2 BC - \text{Cosine}^2 AB$; and $\text{Sine}^2 AC = \text{Radius}^2 - \text{Cosine}^2 AC$; so that $\text{Radius}^2 - \text{Cosine}^2 AC = \frac{\text{Radius}^2}{\text{Cosine}^2 BC} \times \text{Cosine}^2 BC - \text{Cosine}^2 AC \times \text{Cosine}^2 BC = \text{Cosine}^2 AB$ or $\text{Cosine}^2 BC \text{ Radius}^2 \times \text{Cosine}^2 BC - \text{Cosine}^2 AC \times \text{Cosine}^2 BC = \text{Radius}^2 \times \text{Cosine}^2 BC - \text{Radius}^2 \times \text{Cosine}^2 AB$, that is $\text{Cosine}^2 AC \times \text{Cosine}^2 BC = \text{Radius}^2 \times \text{Cosine}^2 AB$; and $\text{Cosine } AC \times \text{Cosine } BC = \text{Radius} \times \text{Cosine } AB$ conformably to Napier's rule.

When BC is a small Arc, and $\text{Radius} = \text{Cosine } BC$ nearly, they omit the second part of the operation, and suppose $\text{Sine } AC = \sqrt{\text{Sine}^2 AB - \text{Sine}^2 BC}$.

3^d. Let ABD be an oblique angled Spherical Triangle, in which two sides AB and AD, and the included angle A are given; to find the third side BD. The method is as follows:

$$\text{First, Sine AB : Cosine AB :: Cosine AD : Sine W} = \frac{\text{Cosine AB} \times \text{Cosine AD}}{\text{Sine AB}}$$

$$\text{Secondly, Sine AD : Sine W :: Radius : Sine X} = \frac{\text{Radius} \times \text{Sine W}}{\text{Sine AD}} = \frac{\text{Rad.} \times \text{Cos. AB} \times \text{Cos. AD}}{\text{Sine AB} \times \text{Sine AD}}$$

$$\text{Thirdly, Cosine A + Sine X = Sine Y} = \frac{\text{Cos. A} \times \text{Sine AB} \times \text{Sine AD} + \text{Rad.} \times \text{Cos. AB} \times \text{Cos. AD}}{\text{Sine AB} \times \text{Sine AD}}$$

$$\begin{aligned} \text{Fourthly, Radius : Sine Y :: Sine AD : Sine Z} &= \frac{\text{Sine Y} \times \text{Sine AD}}{\text{Radius}} = \\ &= \frac{\text{Cosine A} \times \text{Sine AB} \times \text{Sine AD} + \text{Radius} \times \text{Cosine AB} \times \text{Cosine AD}}{\text{Radius} \times \text{Sine AB}} \end{aligned}$$

$$\begin{aligned} \text{Fifthly, Radius : Sine Z :: Sine AB : Cosine BD} &= \frac{\text{Sine Z} \times \text{Sine AB}}{\text{Radius}} = \\ &= \frac{\text{Cosine A} \times \text{Sine AB} \times \text{Sine AD} + \text{Radius} \times \text{Cosine AB} \times \text{Cosine AD}}{\text{Radius}} \end{aligned}$$

This is a correct value of Cosine BD; but sometimes they bring out the same result in another manner, as follows:

$$\text{First, Find as before Sine W} = \frac{\text{Cosine AB} \times \text{Cosine AD}}{\text{Sine AB}}$$

$$\text{Secondly, Find also Sine X} = \frac{\text{Radius} \times \text{Cosine AB} \times \text{Cosine AD}}{\text{Sine AB} \times \text{Sine AD}}$$

$$\text{Thirdly, Radius + Sine X} = \frac{\text{Radius} \times \text{Sine AB} \times \text{Sine AD} + \text{Radius} \times \text{Cosine AB} \times \text{Cosine AD}}{\text{Sine AB} \times \text{Sine AD}}$$

$$\begin{aligned} \text{Fourthly, Sine Z} - \text{Vers. Sine A} = \text{Sine Q} - \text{Radius} + \text{Cosine A} = \text{Sine Y} = \\ = \frac{\text{Cosine A} \times \text{Sine AB} \times \text{Sine AD} + \text{Radius} \times \text{Cosine AB} \times \text{Cosine AD}}{\text{Sine AB} \times \text{Sine AD}} \end{aligned}$$

Lastly, Sine Z, and Cosine BD, are to be found as in the former method.

4^d. When the three sides of a Spherical Triangle are given, to find an angle A, the foregoing operations are reversed, as follows:

$$\text{First, Sine AB : Cosine BD :: Radius : Sine Z} = \frac{\text{Radius} \times \text{Cosine BD}}{\text{Sine AB}}$$

$$\text{Secondly, Sine AD : Sine Z :: Radius : Sine Y} = \frac{\text{Rad.} \times \text{Sine Z}}{\text{Sine AD}} = \frac{\text{Radius} \times \text{Cosine BD}}{\text{Sine AB} \times \text{Sine AD}}$$

$$\text{Thirdly, Sine AB : Cosine AB :: Cosine AD : Sine W} = \frac{\text{Cosine AB} \times \text{Cosine AD}}{\text{Sine AB} \times \text{Sine AD}}$$

$$\text{Fourthly, Sine AD : Sine W :: Radius : Sine X} = \frac{\text{Rad.} \times \text{Sine W}}{\text{Sine AD}}$$

$$\text{Fifthly, Cosine A} = \text{Sine Y} - \text{Sine X} = \frac{\text{Radius} \times \text{Cosine BD} - \text{Rad.} \times \text{Cosine AB} \times \text{Cosine AD}}{\text{Sine AB} \times \text{Sine AD}}$$

The value of Cosine A thus found is correct, and leaves scarcely any reason to doubt of the people of India being possessed of proper rules for solving all the other cases of Trigonometry, although I have not hitherto met with them.

The preceding Theorems will be found sufficient to demonstrate every case of Hindu Gnomonics, as resolved in the second Memoir of this work.

A SET OF TABLES

For facilitating the resolution of Astronomical and Gnomonic Problems, according to the theories delivered in the second Memoir.

TABLE XXXI.

For converting parts of the Equinoct into Indian time and vice versa.

Degrees into Time.				Time into Degrees.							
°	G.	Y.	•	G.	Y.	Vigud.	•	Vig.	•	Guddias.	•
°	P.	P.	•	P.	P.	Paras.	•	Par.	•	•	•
°	P.	S.	•	P.	S.	Saras.	•	Sar.	•	Guddias.	•
1	0	10	10	1	40	1	0	6	10	1	6
2	0	20	20	3	20	2	0	12	20	2	12
3	0	30	30	5	0	3	0	18	30	3	18
4	0	40	40	6	40	4	0	24	40	4	24
5	0	50	50	8	20	5	0	30	50	5	30
6	0	60	60	10	0	6	0	36	60	6	36
7	1	10	120	30	0	7	0	42		7	42
8	1	20	180	30	0	8	0	48		8	48
9	1	30	240	40	0	9	0	54		9	54
10	1	40	300	50	0	10	1	0		10	60
			360	60	0						

TABLE XXXII.

Shewing the Sun's Declination, Right Ascension and Amplitude, when his Longitude is I, II and III Signs; which quantities are constant, and applicable to all places.

Signs.	Sun's Longitude.	Sines.	Sun's Declination.	Sines.	Logns.	Agrs.	Sines.
I	Yekajya or Sine of 30	1719	11 43	603	1670	12 1	716
II	Duoajya do. of 60	2978	20 38	1211	1795	21 12	1243
III	Trījaya do. of 90	3433	20 0	1397	1935	24 40	1424

The Chars Cunda, and Ullagna, are to be calculated for the specific place computed for.

TABLE XXXIII.

Exhibiting the Latitudes and Longitudes of certain principal places in India, referred to the Rēcha or Meridian of Lanka, such as found in some of the Indian Ephemerides annexed to the Solar and Lunar Solar Patras, or Kalendars; the circumference of the Equatorial Circle being = 5050,3 yojanas.

Names of Places.	Latitudes or Arsha Bagahs.			Longitude or Desantara.								In Yojanas.
				In Degrees.				In Time.				
°	'	''	°	'	''	E.	W.	h.	m.	s.	'''	
Delhi	27	35	0 N	1	16	8 E	+0	13	0	0		17
Benares	25	58	0	4	37	0 E	0	46	10	0		64
Oeghin	23	11	30	0	0	0	0	0	0	0		0
Calcutta	22	34	45	12	36	30 E	2	6	5	0		177
Gaujam	19	29	0	9	17	0 E	1	33	0	0		130
Bombay	18	46	40	3	15	0 W	0	32	30	0		-46
Poona	18	30	0	1	41	0 W	0	17	0	0		-34
Chikacole	18	12	0	8	7	0 E	+1	22	0	0		114
Vizagapatam	17	42	0	7	32	45 E	1	15	27	30		106
Hydersbad (Golconda)	17	26	51	2	53	45 E	0	29	47	30		42
Anagoondy	16	30	0	0	0	0	0	0	0	0		0
Benda near Masulipatam	16	15	0	5	19	45 E	0	53	17	30		75
Calcutti	13	58	0	4	8	0 E	0	41	0	0		53
Madras	13	4	12	4	35	45 E	0	43	57	0		65
Bangalore	12	56	49	1	42	18 E	0	17	3	0		23
Mangalore	12	51	38	1	0	12 W	0	10	2	0		-11
Conjeraram	12	51	0	3	59	0 E	+0	40	0	0		50
Seringapatam	12	32	0	0	58	45 E	0	9	47	20		14
Pondicherry	11	55	50	4	0	32 E	6	40	5	20		56
Tanjore	10	47	0	3	18	9 E	0	33	1	30		47
Trivalore	10	44	0	3	32	28 E	0	35	29	41		42
Madura	9	54	0	2	25	0 E	0	24	0	0		31
Rameswaram	9	18	7	3	23	50 E	0	34	48	48		40
Anantichyam (Tiruvancore)	8	26	0	1	22	0 E	0	14	0	0		10

To have the Longitude of any place expressed in yojanas, say, as 300° to 5050,3, as the given Longitude in degrees, to the distance from the first Meridian counted on the Equator, in yojanas.

N. B.—For fine computations the parts of yojanas either in sexagesimals or decimals must be accounted for.

EXAMPLE I.

The Longitude of Benares in degrees being 4° 37'. Say 360° : 5050,3 :: 4° 37' : $\frac{5050,3 \times 4 \times 37}{360}$
= 64,88 yojanas.

EXAMPLE II.

The Longitude of Trivalore in degrees being 3° 32' 58". Say 360° : 5050,3 :: 3° 32' 58" : $\frac{5050,3 \times 3 \times 32 \times 58}{360}$
= 49,88 yojanas.

TABLE XXXIV.

Exhibiting the Palabuh, or Vishama Chayn, the Shadow of the Gnomon at noon on the days of the Equinoxes, and the circumference of the Circle of Longitude called Seva-deen Paridhi, at some of the principal places in India,—the Equatorial Circle being taken to contain 3052,3 yojanas.

Names of Places.	Polar Altitude.	Sines.	Cosines.	Palabuh.		Seva-deen Paridhi. Circumference of Circle of Longitude.
				A.	V.	
Benares - - -	25° 38'	1487,0	3101,9	3	43,1	4564,7
Oogeln - - -	23 12	1852,3	3160,7	5	8,0	4651,2
Calcutta - - -	22 35	1319,5	3173,0	4	50,9	4672,1
Bombay - - -	18 47	1106,8	3255,8	4	4,7	4700,4
Vizagapatam - -	17 42	1042,8	3274,0	3	40,2	4819,3
Hyderabad - - -	17 27	1030,4	3278,6	3	44,4	4824,7
Banda (near Masulipatam).	16 15	961,6	3299,4	3	29,8	4855,3
Madrass - - -	13 4	776,2	3347,4	2	46,8	4925,9
Bangalore - - -	12 37	770,2	3348,9	2	45,5	4928,2
Mangalore - - -	12 52	765,4	3350,1	2	44,4	4929,8
Seringapatam - -	12 32	745,9	3354,6	2	40,0	4936,5
Pondicherry - - -	11 57	711,3	3362,7	2	32,2	4948,4
Tanjore - - -	10 47	643,3	3376,7	2	17,1	4969,1
Trivalore - - -	10 44	640,4	3377,1	2	16,5	4969,6
Ramissorum - - -	9 18	555,5	3394,8	1	37,9	4991,3

By help of this Table the *Lagna*, *Chara Gunda*, and *Ullagna* of any place therein registered, may be readily computed.

For finding the difference of Longitude in time under any parallel of Latitude, say: As circumference of Circle of Longitude at that place, to 60 guddias, (or dandas), so the Longitude in yojanas counted on the Equatorial Circle, to the difference of Longitude in time of the place computed for.

EXAMPLE I.

For Benares, the Longitude of which is 64,32 yojanas East of Lanka.

Table IV. $4564,7 : 60^\circ :: 64,32 \text{ \&c.} : \frac{60 \times 64,32}{4564,7} = 0^\circ 51' 10'' 5''$

EXAMPLE II.

For Trivalore, its Longitude in yojanas being 49,88 &c.

$4969,6 : 60^\circ :: 49,88 \text{ \&c.} : \frac{60 \times 49,88}{4969,6} = 0^\circ 35' 8'' 21''$

TABLE XXXV.

Showing the *Ayanamsa* for Secular years, from A. D. 0, to the Julian year 2000, concurrent with the years *Cali yugam* 3101, and 5101; or 78 years before and 1922 after the birth of *Sittukhanu*; giving at the same time the Sun's *Ravi Sayana* or Longitude at the commencement of each Secular *Sidereal* year.

Date in March O. S.	Julian Secular years.	Years elapsed of the <i>Ära Cali yug.</i>	<i>Ayanamsa.</i>	Longitude.	Table for finding the <i>Ayanamsa</i> for odd years.																																																																																																																																
			<i>Second Padah.</i>																																																																																																																																		
14	0	3101	7 29 6	11 22 30 54	<table><tr><td>Y.</td><td>1</td><td>2</td><td>3</td><td>Y.</td><td>1</td><td>2</td><td>3</td></tr><tr><td>1</td><td>0 54</td><td>70</td><td>1 3</td><td>1</td><td>0 54</td><td>70</td><td>1 3</td></tr><tr><td>2</td><td>1 48</td><td>80</td><td>1 12</td><td>2</td><td>1 48</td><td>80</td><td>1 12</td></tr><tr><td>3</td><td>2 42</td><td>90</td><td>1 21</td><td>3</td><td>2 42</td><td>90</td><td>1 21</td></tr><tr><td>4</td><td>3 36</td><td>100</td><td>1 30</td><td>4</td><td>3 36</td><td>100</td><td>1 30</td></tr><tr><td>5</td><td>4 30</td><td>200</td><td>3 0</td><td>5</td><td>4 30</td><td>200</td><td>3 0</td></tr><tr><td>6</td><td>5 24</td><td>300</td><td>4 30</td><td>6</td><td>5 24</td><td>300</td><td>4 30</td></tr><tr><td>7</td><td>6 18</td><td>400</td><td>5 0</td><td>7</td><td>6 18</td><td>400</td><td>5 0</td></tr><tr><td>8</td><td>7 12</td><td>500</td><td>7 30</td><td>8</td><td>7 12</td><td>500</td><td>7 30</td></tr><tr><td>9</td><td>8 6</td><td>600</td><td>9 0</td><td>9</td><td>8 6</td><td>600</td><td>9 0</td></tr><tr><td>10</td><td>9 0</td><td>700</td><td>10 30</td><td>10</td><td>9 0</td><td>700</td><td>10 30</td></tr><tr><td>20</td><td>18 0</td><td>800</td><td>12 0</td><td>20</td><td>18 0</td><td>800</td><td>12 0</td></tr><tr><td>30</td><td>27 0</td><td>900</td><td>13 30</td><td>30</td><td>27 0</td><td>900</td><td>13 30</td></tr><tr><td>40</td><td>36 0</td><td>1000</td><td>15 0</td><td>40</td><td>36 0</td><td>1000</td><td>15 0</td></tr><tr><td>50</td><td>45 0</td><td></td><td></td><td>50</td><td>45 0</td><td></td><td></td></tr><tr><td>60</td><td>54 0</td><td></td><td></td><td>60</td><td>54 0</td><td></td><td></td></tr></table>	Y.	1	2	3	Y.	1	2	3	1	0 54	70	1 3	1	0 54	70	1 3	2	1 48	80	1 12	2	1 48	80	1 12	3	2 42	90	1 21	3	2 42	90	1 21	4	3 36	100	1 30	4	3 36	100	1 30	5	4 30	200	3 0	5	4 30	200	3 0	6	5 24	300	4 30	6	5 24	300	4 30	7	6 18	400	5 0	7	6 18	400	5 0	8	7 12	500	7 30	8	7 12	500	7 30	9	8 6	600	9 0	9	8 6	600	9 0	10	9 0	700	10 30	10	9 0	700	10 30	20	18 0	800	12 0	20	18 0	800	12 0	30	27 0	900	13 30	30	27 0	900	13 30	40	36 0	1000	15 0	40	36 0	1000	15 0	50	45 0			50	45 0			60	54 0			60	54 0		
Y.	1	2	3	Y.	1	2	3																																																																																																																														
1	0 54	70	1 3	1	0 54	70	1 3																																																																																																																														
2	1 48	80	1 12	2	1 48	80	1 12																																																																																																																														
3	2 42	90	1 21	3	2 42	90	1 21																																																																																																																														
4	3 36	100	1 30	4	3 36	100	1 30																																																																																																																														
5	4 30	200	3 0	5	4 30	200	3 0																																																																																																																														
6	5 24	300	4 30	6	5 24	300	4 30																																																																																																																														
7	6 18	400	5 0	7	6 18	400	5 0																																																																																																																														
8	7 12	500	7 30	8	7 12	500	7 30																																																																																																																														
9	8 6	600	9 0	9	8 6	600	9 0																																																																																																																														
10	9 0	700	10 30	10	9 0	700	10 30																																																																																																																														
20	18 0	800	12 0	20	18 0	800	12 0																																																																																																																														
30	27 0	900	13 30	30	27 0	900	13 30																																																																																																																														
40	36 0	1000	15 0	40	36 0	1000	15 0																																																																																																																														
50	45 0			50	45 0																																																																																																																																
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16	200	3301	4 20 0	11 25 30 54																																																																																																																																	
16	300	3401	2 50 0	11 27 0 54																																																																																																																																	
17	400	3501	1 20 6	11 28 30 54																																																																																																																																	
18	409	3600	0 0 0	0 0 0 0																																																																																																																																	
			<i>Third Padah. (*)</i>																																																																																																																																		
18	500	3601	+0 0 54	In this Padah the <i>Ayanamsa</i> is additive and follows the order of the Zodiacal Signs.	<table><tr><th>Date in April N. S.</th><th>5</th><th>6</th><th>8</th><th>10</th><th>12</th><th>13</th></tr><tr><td>5</td><td></td><td></td><td></td><td></td><td></td><td></td></tr><tr><td>6</td><td></td><td></td><td></td><td></td><td></td><td></td></tr><tr><td>8</td><td></td><td></td><td></td><td></td><td></td><td></td></tr><tr><td>10</td><td></td><td></td><td></td><td></td><td></td><td></td></tr><tr><td>12</td><td></td><td></td><td></td><td></td><td></td><td></td></tr><tr><td>13</td><td></td><td></td><td></td><td></td><td></td><td></td></tr></table>	Date in April N. S.	5	6	8	10	12	13	5							6							8							10							12							13																																																																																					
Date in April N. S.	5	6	8		10	12	13																																																																																																																														
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20	800	3901	4 30 54																																																																																																																																		
21	900	4001	6 0 54																																																																																																																																		
22	1000	4101	7 30 54																																																																																																																																		
23	1100	4201	9 0 54																																																																																																																																		
24	1200	4301	10 30 54																																																																																																																																		
25	1300	4401	12 0 54																																																																																																																																		
26	1400	4501	13 30 54																																																																																																																																		
27	1500	4601	15 0 54																																																																																																																																		
27	1600	4701	16 30 54																																																																																																																																		
28	1700	4801	18 0 54																																																																																																																																		
29	1800	4901	19 30 54																																																																																																																																		
30	1900	5001	21 0 54																																																																																																																																		
31	2000	5101	22 30 54																																																																																																																																		

EXAMPLE.

How to find the *Ayanamsa* for the year *Cali yugam* 4846 complete, corresponding to A. D. 1745, on Friday the 9th April N. S.

<i>Cali yug.</i>	A. D.			
4801	1700	18	0	54
40	40		36	0
5	5		4	30
4846	1745	18	41	24 0
By the Siddhanta Rule		18	41	23 11
			Difference	49

(*) In the 3d Quadrant of the *Ayanamsa*, the quantities given in the 4th column show both the *Ayanamsa* and the Longitude of the 1st point in *Meṣa Y* at the beginning of the year.

TABLE XXXVI.

Being auxiliary to the XXXVth, for finding the error of the Sun's mean Longitude as computed in the Hindu Solar Tables, when referred to the European Tables.

Julian Secular years.	Years expired since the Epoch Call' yug.	Ayanansa, the Granti Patagall being supposed $54^{\circ} 1' 15''$.								Table for finding the Ayanansa for odd years.										
		<i>Second Padah.</i>																		
0	3101	7	29	16	19	11	22	30	4	1	0	34	1	15	70	1	3	1	50	20
100	3201	5	29	14	19	11	24	0	45	2	1	48	2	30	80	1	12	1	59	0
200	3301	4	29	12	13	11	25	30	47	3	2	42	3	45	90	1	21	1	51	30
300	3401	2	29	10	7	11	27	0	49	4	3	36	5	0	100	1	50	2	4	0
400	3501	1	29	8	3	11	28	30	51	5	4	30	6	15	200	3	0	4	10	0
	3600	0	0	0	0	0	0	0	0	6	5	24	7	30	300	4	30	6	15	0
		<i>Third Padah.</i>								7	6	18	8	45	400	6	0	8	20	0
500	3701	+	54	1						8	7	12	10	0	500	7	20	10	25	0
600	3701	1	30	56	6					9	8	6	11	15	600	9	0	12	50	0
700	3801	3	0	58	11					10	9	0	12	30	700	10	30	14	35	0
800	3901	4	31	0	16					20	18	0	24	0	800	12	0	16	40	0
900	4001	5	1	2	21					30	27	0	36	30	900	13	30	18	45	0
1000	4101	7	31	4	26					40	36	0	48	0	1000	15	0	20	50	0
1100	4201	9	1	6	31					50	45	1	1	30						
1200	4301	10	21	8	36					60	54	1	15	0						
1300	4401	12	1	10	41															
1400	4501	13	31	12	46															
1500	4601	15	1	14	51															
1600	4701	16	31	16	56															
1700	4801	18	1	19	1															
1800	4901	19	31	21	6															
1900	5001	21	1	23	11															
2000	5101	22	31	25	16															

Table XXXV is to Table XXXVI

In the constant ratio of $\frac{54^{\circ}}{54^{\circ} 1' 15''} = x$;

vide Appendix II.

Table XXXV is to Table XXXVI

In the constant ratio of $\frac{54^{\circ}}{54^{\circ} 1' 15''} = x;$

vide Appendix II.

TIDHI TABLE XXIV.

Index.	Equation.				Diurnal motion.	Index.	Equation.				Diurnal motion.	Index.	Equation.				Diurnal motion.	Index.	Equation.				Diurnal motion.
1	2	4	11	2	22	24	20	12	23	43	1	43	13	25	64	24	49	12	10				
2	4	7	11	3	23	24	7	12	30	44	3	25	13	26	65	24	48	12	5				
3	6	8	11	5	24	23	37	12	35	45	6	6	13	19	66	24	32	12	0				
4	8	6	11	7	25	23	1	12	40	46	6	43	13	18	67	24	18	11	55				
5	9	56	11	9	26	22	17	12	44	47	8	25	13	16	68	23	51	11	30				
6	11	49	12	12	27	21	27	12	48	48	9	58	13	14	69	23	15	11	45				
7	13	33	14	15	28	20	30	12	52	49	11	31	13	12	70	22	30	11	40				
8	15	19	11	18	29	19	27	12	56	50	13	6	13	9	71	21	37	11	35				
9	16	43	11	22	30	18	19	13	0	51	14	20	13	8	72	20	34	11	30				
10	18	8	11	26	31	17	6	13	3	52	15	42	13	3	73	19	25	11	25				
11	19	23	11	30	32	15	48	13	6	53	17	6	13	0	74	18	8	11	22				
12	20	35	11	35	33	14	26	13	9	54	18	10	12	26	75	16	43	11	18				
13	21	37	11	40	34	13	0	13	12	55	19	27	12	22	76	15	12	11	15				
14	22	30	11	45	35	11	31	13	14	56	20	30	12	48	77	13	33	11	12				
15	23	15	11	50	36	9	55	13	16	57	21	27	12	43	78	11	49	11	9				
16	23	51	11	55	37	8	23	13	18	58	22	17	12	40	79	9	59	11	7				
17	24	12	12	0	38	6	45	13	16	59	23	1	12	35	80	8	6	11	5				
18	24	34	12	5	39	5	6	13	20	60	23	37	12	30	81	6	1	11	3				
19	24	43	12	10	40	3	23	13	20	61	24	37	12	25	82	4	7	11	2				
20	24	49	12	15	41	1	43	13	21	62	24	29	12	20	83	2	4	11	2				
21	24	43	12	20	42	0	0	13	21	63	24	43	12	15	84	0	0	11	2				

NACSHATRA TABLE XXXVIII.

Index.	Equation.	Index.	Equation.	Index.	Equation.	Index.	Equation.	Index.	Equation.	Index.	Equation.	Index.	Equation.
1	2 0	13	20 29	33	20 20	37	4 58	49	14 1	61	22 58	73	12 0
2	3 52	14	21 16	34	19 39	38	3 20	50	15 18	62	22 56	74	11 22
3	5 54	15	21 53	37	18 42	39	1 40	51	16 31	63	22 42	75	9 36
4	7 47	16	22 22	38	17 32	40	0 0	52	17 30	64	22 22	76	7 47
5	9 56	17	22 42	39	16 31	41	1 40	53	18 42	65	21 52	77	5 54
6	11 21	18	22 53	40	15 18	42	3 20	54	19 30	66	21 16	78	3 58
7	13 0	19	22 58	41	14 1	43	4 58	55	20 20	67	20 20	79	2 0
8	14 39	20	22 53	42	12 30	44	6 35	56	21 13	68	19 53	80	0 0
9	15 59	21	22 30	43	11 18	45	8 10	57	21 40	69	18 30		
10	17 10	22	22 18	44	9 42	46	9 42	58	22 18	70	17 19		
11	18 30	23	21 40	45	8 10	47	11 12	59	22 30	71	15 59		
12	19 23	24	21 13	46	6 35	48	12 39	60	22 53	72	14 33		

YOGA TABLE XXXIX.

Index.	Equation.	Diurnal motion.	Index.	Equation.	Diurnal motion.	Index.	Equation.	Diurnal motion.	Index.	Equation.	Diurnal motion.
1	1 43	13 0	23	21 0	14 23	45	2 54	15 18	67	21 16	14 0
2	3 25	13 1	24	20 40	14 30	46	4 20	15 17	68	21 3	13 55
3	5 5	13 2	25	20 13	14 34	47	5 45	15 16	69	20 43	13 50
4	6 43	13 3	26	19 30	14 39	48	7 2	15 14	70	20 16	13 45
5	8 18	13 7	27	19 2	14 43	49	8 29	15 12	71	19 42	13 40
6	9 50	13 9	28	18 18	14 47	50	9 48	15 10	72	19 1	13 35
7	11 18	13 12	29	17 29	14 51	51	11 4	15 8	73	13 13	13 31
8	12 41	13 15	30	16 35	14 53	52	12 12	15 5	74	17 19	13 27
9	13 29	13 19	31	15 37	14 59	53	13 29	15 2	75	16 18	13 23
10	15 11	13 23	32	14 34	15 2	54	14 34	14 59	76	15 11	13 19
11	16 18	13 27	33	13 25	15 6	55	15 37	14 55	77	13 59	13 15
12	17 10	13 31	34	12 18	15 8	56	16 35	14 51	78	12 41	13 11
13	18 13	13 35	35	11 41	15 10	57	17 29	14 47	79	11 18	13 8
14	19 1	13 40	36	9 48	15 12	58	18 18	14 43	80	9 50	13 2
15	19 42	13 45	37	9 29	15 14	59	19 2	14 39	81	8 18	13 5
16	20 16	13 50	38	7 8	15 16	60	19 40	14 34	82	6 43	13 3
17	20 43	13 55	39	5 45	15 17	61	20 13	14 30	83	5 6	13 1
18	21 3	14 0	40	4 20	15 18	62	20 40	14 25	84	3 25	13 0
19	21 16	14 3	41	2 54	15 19	63	21 0	14 20	85	1 43	13 0
20	21 22	14 10	42	1 27	15 19	64	21 14	14 15	86	0 0	13 0
21	21 21	14 12	43	0 0	15 19	65	21 21	14 10			
22	21 14	14 20	44	1 27	15 19	66	21 22	14 5			

SOLAR TABLE XL.

Index.	Equation.	Diurnal Arc.	Index.	Equation.	Diurnal Arc.	Index.	Equation.	Diurnal Arc.	Index.	Equation.	Diurnal Arc.
1	0 2 16	13 41	41	1 20 10	13 51	87	2 9 52	14 33	130	1 45 32	15 27
2	0 4 31	13 41	42	1 30 46	13 51	88	2 10 4	14 35	131	1 44 35	15 28
3	0 6 47	13 41	43	1 42 23	13 51	89	2 10 14	14 36	132	1 43 15	15 29
4	0 9 15	13 40	44	1 53 53	13 52	90	2 10 25	14 37	133	1 41 52	15 31
5	0 11 17	13 40	45	1 55 23	13 51	91	2 10 24	14 38	134	1 40 29	15 32
6	0 13 28	13 40	46	1 56 52	13 51	92	2 10 22	14 39	135	1 39 5	15 33
7	0 15 47	13 39	47	1 58 23	13 50	93	2 10 30	14 41	136	1 37 37	15 35
8	0 18 1	13 39	48	1 59 48	13 50	94	2 10 30	14 42	137	1 35 7	15 36
9	0 20 14	13 39	49	1 41 11	13 50	95	2 10 22	14 44	138	1 34 27	15 37
10	0 22 27	13 39	50	1 42 32	13 50	96	2 10 17	14 44	139	1 33 7	15 38
11	0 24 39	13 39	51	1 43 53	13 50	97	2 10 10	14 45	140	1 31 33	15 39
12	0 26 51	13 39	52	1 45 13	14 0	98	2 9 53	14 47	141	1 29 57	15 41
13	0 29 2	13 39	53	1 46 39	14 1	99	2 9 45	14 48	142	1 28 21	15 42
14	0 31 13	13 39	54	1 47 46	14 2	100	2 9 31	14 49	143	1 26 41	15 43
15	0 33 23	13 39	55	1 49 1	14 2	101	2 9 14	14 51	144	1 25 4	15 44
16	0 35 33	13 39	56	1 50 11	14 3	102	2 8 54	14 52	145	1 23 22	15 45
17	0 37 41	13 39	57	1 51 21	14 4	103	2 8 23	14 53	146	1 21 40	15 46
18	0 39 49	13 39	58	1 52 23	14 5	104	2 8 11	14 54	147	1 19 56	15 47
19	0 41 56	13 39	59	1 53 24	14 6	105	2 7 46	14 55	148	1 18 10	15 49
20	0 44 2	13 40	60	1 54 28	14 7	106	2 7 10	14 57	149	1 16 23	15 50
21	0 46 7	13 40	61	1 55 38	14 8	107	2 6 45	14 58	150	1 14 33	15 51
22	0 48 12	13 40	62	1 56 38	14 9	108	2 6 10	14 59	151	1 12 45	15 52
23	0 50 16	13 40	63	1 57 38	14 10	109	2 5 41	14 59	152	1 10 53	15 53
24	0 52 19	13 40	64	1 58 33	14 11	110	2 5 4	15 0	153	1 9 1	15 54
25	0 54 21	13 40	65	1 59 25	14 12	111	2 4 27	15 0	154	1 7 8	15 55
26	0 56 21	13 41	66	2 0 40	14 13	112	2 3 47	15 0	155	1 5 14	15 56
27	0 58 21	13 41	67	2 1 10	14 14	113	2 3 4	15 0	156	1 3 17	15 57
28	1 0 21	13 41	68	2 1 57	14 15	114	2 2 19	15 0	157	1 1 10	15 58
29	1 2 19	13 42	69	2 2 42	14 16	115	2 1 33	15 0	158	0 59 21	16 0
30	1 4 16	13 42	70	2 3 20	14 17	116	2 0 46	15 0	159	0 57 21	16 0
31	1 6 11	13 43	71	2 4 6	14 18	117	1 59 53	15 11	160	0 55 21	16 0
32	1 8 5	13 43	72	2 4 46	14 19	118	1 58 59	15 12	161	0 53 19	16 0
33	1 9 56	13 41	73	2 5 23	14 21	119	1 58 5	15 13	162	0 51 17	16 0
34	1 11 50	13 41	74	2 5 59	14 22	120	1 57 9	15 13	163	0 49 14	16 0
35	1 13 40	13 45	75	2 6 31	14 23	121	1 56 0	15 16	164	0 47 10	16 0
36	1 15 30	13 45	76	2 7 1	14 24	122	1 55 9	15 17	165	0 45 5	16 0
37	1 17 17	13 46	77	2 7 31	14 25	123	1 54 7	15 18	166	0 42 59	16 0
38	1 19 4	13 47	78	2 8 1	14 26	124	1 53 4	15 20	167	0 40 52	16 0
39	1 20 49	13 47	79	2 8 21	14 28	125	1 51 54	15 21	168	0 38 45	16 0
40	1 22 32	13 48	80	2 8 44	14 29	126	1 50 44	15 22	169	0 35 37	16 0
41	1 24 14	13 49	81	2 9 4	14 30	127	1 49 31	15 23	170	0 34 28	16 10
42	1 25 54	13 49	82	2 9 24	14 31	128	1 48 24	15 24	171	0 32 18	16 11
43	1 27 21	13 50	83	2 9 39	14 32	129	1 47 9	15 25	172	0 30 8	16 11

SOLAR TABLE, *continued.*

Index.	Equation.	1 Diurnal Arc.	Index.	Equation.	1 Diurnal Arc.	Index.	Equation.	1 Diurnal Arc.	Index.	Equation.	1 Diurnal Arc.
172	0 27 57	16 12	216	1 5 14	16 19	259	2 3 47	15 47	302	2 0 20	14 53
174	0 25 43	16 12	217	1 7 8	16 19	260	2 4 27	15 46	303	1 59 27	14 53
175	0 23 33	16 14	218	1 9 1	16 16	261	2 5 3	15 45	304	1 58 33	14 52
176	0 21 20	16 14	219	1 10 23	16 18	262	2 5 41	15 44	305	1 57 38	14 51
177	0 19 7	16 14	220	1 12 45	16 17	263	2 6 16	15 43	306	1 56 38	14 49
178	0 16 54	16 15	221	1 14 35	16 17	264	2 6 40	15 42	307	1 55 26	14 48
179	0 14 40	16 16	222	1 16 23	16 18	265	2 7 16	15 41	308	1 54 38	14 47
180	0 12 25	16 16	223	1 18 10	16 16	266	2 7 45	15 40	309	1 53 36	14 45
181	0 10 10	16 17	224	1 19 56	16 15	267	2 8 12	15 39	310	1 52 29	14 44
182	0 7 35	16 17	225	1 21 40	16 14	268	2 8 54	15 37	311	1 51 21	14 43
183	0 5 40	16 17	226	1 23 32	16 14	269	2 8 54	15 36	312	1 50 11	14 41
184	0 3 24	16 18	227	1 25 3	16 13	270	2 9 16	15 35	313	1 49 1	14 40
185	0 1 8	16 18	228	1 26 44	16 13	271	2 9 31	15 34	314	1 47 46	14 39
186	0 1 8	16 18	229	1 28 21	16 12	272	2 9 46	15 33	315	1 46 30	14 37
187	0 3 24	16 19	230	1 29 57	16 12	273	2 9 52	15 31	316	1 45 13	14 36
188	0 5 40	16 20	231	1 31 33	16 11	274	2 10 10	15 30	317	1 43 53	14 35
189	0 7 35	16 20	232	1 33 7	16 10	275	2 10 17	15 29	318	1 42 39	14 33
190	0 10 10	16 20	233	1 34 37	16 10	276	2 10 22	15 28	319	1 41 11	14 32
191	0 12 25	16 20	234	1 35 7	16 10	277	2 10 26	15 26	320	1 39 48	14 31
192	0 14 40	16 20	235	1 37 37	16 8	278	2 10 30	15 25	321	1 38 23	14 30
193	0 16 54	16 21	236	1 39 5	16 8	279	2 10 38	15 24	322	1 36 53	14 28
194	0 19 7	16 21	237	1 40 29	16 7	280	2 10 34	15 23	323	1 35 23	14 27
195	0 21 20	16 21	238	1 41 52	16 6	281	2 10 30	15 22	324	1 33 53	14 26
196	0 23 33	16 21	239	1 43 15	16 5	282	2 10 14	15 21	325	1 32 21	14 24
197	0 25 43	16 21	240	1 44 35	16 4	283	2 10 4	15 19	326	1 30 46	14 23
198	0 27 57	16 22	241	1 45 53	16 4	284	2 9 52	15 18	327	1 29 10	14 22
199	0 30 3	16 22	242	1 47 9	16 3	285	2 9 39	15 17	328	1 27 34	14 20
200	0 32 18	16 22	243	1 48 24	16 1	286	2 9 24	15 15	329	1 25 54	14 19
201	0 34 28	16 22	244	1 49 54	16 1	287	2 9 4	15 14	330	1 24 14	14 18
202	0 36 37	16 22	245	1 50 44	16 0	288	2 8 44	15 13	331	1 22 32	14 17
203	0 38 45	16 22	246	1 51 54	15 50	289	2 8 24	15 12	332	1 20 49	14 16
204	0 40 52	16 22	247	1 53 4	15 55	290	2 8 1	15 10	333	1 19 4	14 14
205	0 42 59	16 22	248	1 54 7	15 58	291	2 7 51	15 9	334	1 17 17	14 13
206	0 45 5	16 22	249	1 55 9	15 57	292	2 7 1	15 8	335	1 15 30	14 12
207	0 47 10	16 21	250	1 56 9	15 56	293	2 6 31	15 7	336	1 13 46	14 11
208	0 49 14	16 21	251	1 57 0	15 55	294	2 5 59	15 6	337	1 11 56	14 10
209	0 51 17	16 21	252	1 58 5	15 54	295	2 5 23	15 4	338	1 9 58	14 8
210	0 53 19	16 21	253	1 58 50	15 53	296	2 4 40	15 3	339	1 8 3	14 7
211	0 55 21	16 20	254	1 59 53	15 53	297	2 4 6	15 1	340	1 6 12	14 6
212	0 57 21	16 20	255	2 0 46	15 51	298	2 3 26	15 0	341	1 4 16	14 5
213	0 59 21	16 20	256	2 1 33	15 50	299	2 2 42	14 58	342	1 2 19	14 4
214	1 1 19	16 20	257	2 2 10	15 49	300	2 1 57	14 58	343	1 0 21	14 3
215	1 3 17	16 19	258	2 3 4	15 48	301	2 1 10	14 56	344	0 58 21	14 2

SOLAR TABLE, *continued.*

Index.	Equation.	Diurnal Arc.	Index.	Equation.	Diurnal Arc.	Index.	Equation.	Diurnal Arc.	Index.	Equation.	Diurnal Arc.
345	0 56 31	14 1	353	0 39 49	13 54	361	0 21 27	13 40	369	0 4 31	13 43
346	0 54 21	14 0	354	0 37 41	13 53	362	0 20 14	13 40	370	0 2 16	13 42
347	0 52 19	13 59	355	0 35 33	13 51	363	0 18 1	13 40	371	0 0 0	13 41
348	0 50 16	13 58	356	0 33 25	13 50	364	0 15 47	13 41			
349	0 48 12	13 57	357	0 31 13	13 50	365	0 13 32	13 44			
350	0 46 7	13 56	358	0 29 2	13 49	366	0 11 17	13 44			
			359	0 26 51	13 48	367	0 9 2	13 43			
351	0 44 2	13 55	360	0 24 30	13 47	368	0 6 43	13 42			
352	0 41 59	13 54									

TABLE XII.

§ 1.

Of the mean motion of Mars, for days.

Days.	Mean motion.					Days.	Mean motion.				
	°.	'	"	'''	''''		°.	'	"	'''	''''
1	0	0	31	26	28	1000	5	14	1	0	46
2	0	0	2	22	56	2000	10	29	2	10	32
3	0	1	34	19	25	3000	4	12	3	20	17
4	0	2	5	43	33	4000	0	26	4	30	3
5	0	2	37	12	21	5000	3	10	5	48	49
6	0	3	8	38	40	6000	8	24	6	58	35
7	0	3	40	5	17	7000	2	8	8	8	21
8	0	4	11	31	45	8000	7	22	9	13	7
9	0	4	42	53	14	9000	1	6	10	27	52
10	0	5	14	21	42	10000	6	20	11	57	38
20	0	10	23	49	24	20000	1	10	23	15	16
30	0	15	43	14	6	30000	8	0	34	52	54
40	0	20	57	38	47	40000	2	20	46	30	33
50	0	26	12	3	29	50000	9	19	58	8	11
60	1	1	26	28	11	60000	4	1	9	43	49
70	1	6	40	52	33	70000	10	21	21	23	27
80	1	11	55	17	23	80000	5	11	33	1	5
90	1	17	9	42	17	90000	0	1	44	38	44
100	1	22	24	6	59	100000	6	21	58	16	22
200	3	14	48	13	57	200000	1	13	52	32	43
300	5	7	12	20	56	300000	8	5	48	49	3
400	6	29	35	27	54	400000	2	27	45	5	27
500	8	22	0	34	53	500000	9	19	41	21	46
600	10	14	24	41	51	600000	4	11	37	38	10
700	9	6	48	48	50	700000	11	3	33	54	32
800	1	26	12	55	48	800000	5	25	30	10	34
900	3	21	37	2	47	900000	0	17	26	27	16
1000	5	14	1	9	46	1000000	7	9	22	43	27

Drops 9° 35' 39" 23".

Epoch for all the Tables A. Call yug 4399 complete.

§ II.
MANGALA PHALA.

Sap. Mean Anomaly.												
		+ 0° — VI°			+ I° — VII°			+ II° — VIII°				
		s	a	s	s	a	s	s	a	s	a	
0	0	0	0	0	5	31	32	10	1	57	30	0
3	45	0	45	45	6	59	48	10	22	45	26	15
7	30	1	33	8	7	6	19	10	40	57	22	30
11	15	2	18	42	7	40	59	10	56	24	18	45
15	0	3	3	30	8	13	43	11	9	4	15	0
18	45	3	47	18	8	44	20	11	19	3	11	15
21	30	4	29	58	9	12	40	11	26	21	7	30
25	15	5	11	27	9	38	32	11	30	41	3	45
30	0	5	51	34	10	1	57	11	32	3	0	0
		— XI° + V°			— X° + IV°			— IX° + III°				
Sap. Mean Anomaly.												

The Argument of this Table is found by subtracting Mars' corrected mean place from that of his Apis.



TABLE of MARS' ANNUAL EQUATION, and CHILA CARNA (*). The Argument of this Table is found by subtracting Mars' mean place corrected, from the Sun's mean place.

§ III.

Commutation.																			
		+ 0°		+ 1°		+ 2°		+ 3°		+ 4°		+ 5°							
°	'	Equation.	Chila carna	Equation.	Chila carna	Equation.	Chila carna	Equation.	Chila carna	Equation.	Chila carna	Equation.	Chila carna	Equation.	Chila carna	°	'		
		• • •	•	• • •	•	• • •	•	• • •	•	• • •	•	• • •	•	• • •	•				
0	0	0 0 0	5682	11 43 45	5481	12 55 58	1037	32 48 11	4090	39 34 8	3019	36 31 22	1874	30	0				
3	45	1 28 58	5678	13 10 20	5471	24 10 17	4940	33 52 0	3960	39 58 8	2875	34 30 1	1743	26	15				
7	30	2 57 16	5667	14 25 52	5379	25 34 28	4741	31 54 32	3839	40 13 17	2750	31 53 1	1618	22	30				
11	15	4 26 0	5651	15 1 20	5318	25 51 22	4651	35 53 42	3708	40 17 30	2682	28 35 6	1503	18	45				
15	0	5 54 15	5629	17 26 0	5252	23 0 40	4547	36 47 32	3575	40 9 2	2440	24 24 27	1402	15	0				
18	45	7 21 54	5601	18 49 23	5181	29 10 44	4429	37 57 7	3440	39 45 49	2295	19 43 2	1317	11	15				
22	30	8 49 32	5567	20 13 7	5103	30 31 25	4327	38 22 24	3303	29 4 13	2162	13 30 32	1251	7	30				
25	15	10 16 45	5528	21 35 5	5023	31 41 54	4210	39 1 41	3162	38 0 7	2011	0 58 6	1209	3	45				
30	0	12 43 45	5481	22 55 58	4937	32 48 11	4090	39 34 8	3019	36 31 22	1874	0 0 0	1195	0	0				
°	'	Equation.	Chila carna	Equation.	Chila carna	Equation.	Chila carna	Equation.	Chila carna	Equation.	Chila carna	Equation.	Chila carna	Equation.	Chila carna	°	'		
		— XI°		— X°		— IX°		— VIII°		— VII°		— VI°							
Commutation.																			

(*) Chila Carna means the true distance of a Planet from the Earth, in contradistinction to his mean distance, or radius of the Deferent.

TABLE XLII.

§ I.

Of the mean motion of Mercury, for days.

Days.	Mean motion.					Days.	Mean motion.				
	s.	°	'	"	'''		s.	°	'	"	'''
1	0	4	15	32	21	1000	4	12	19	6	58
2	0	8	11	3	41	2000	8	24	38	9	56
3	0	12	16	57	2	3000	1	6	57	14	53
4	0	16	22	9	23	4000	6	19	15	19	50
5	0	20	27	41	43	5000	10	1	35	24	48
6	0	24	33	14	4	6000	2	13	54	29	45
7	0	28	38	46	25	7000	6	26	13	34	42
8	1	3	44	18	45	8000	11	8	32	30	41
9	1	6	49	51	6	9000	3	20	51	44	38
10	1	10	55	23	27	10000	5	3	10	49	35
20	2	21	50	46	54	20000	4	6	21	39	12
30	4	2	46	10	21	30000	0	9	22	25	47
40	5	13	41	33	48	40000	8	12	43	18	23
50	6	24	36	57	15	50000	4	15	54	7	59
60	8	3	32	29	42	60000	0	19	4	57	35
70	9	16	27	44	9	70000	8	22	15	47	10
80	10	27	23	7	36	80000	4	25	26	36	46
90	0	8	18	31	3	90000	0	28	37	23	22
100	1	19	13	54	30	100000	9	1	48	13	54
200	3	8	27	42	0	200000	6	3	36	31	23
300	4	27	41	43	29	300000	3	5	24	47	27
400	6	16	55	37	59	400000	0	7	13	3	60
500	8	6	9	32	29	500000	9	2	1	19	43
600	9	25	23	26	59	600000	6	10	49	35	46
700	11	14	37	24	24	700000	3	12	37	51	43
800	1	3	51	15	58	800000	0	14	26	7	41
900	2	23	5	10	23	900000	9	16	14	23	38
1000	4	12	19	4	58	1000000	6	18	2	39	36

-Days 10° 26' 48" 0".

TABLE XLIII.

§ 1.

Of Jupiter's mean motion for days.

Days.	Mean motion.					Days.	Mean motion.				
	°	'	"	'''	''''		°	'	"	'''	''''
1	0	0	4	59	9	1000	2	23	5	46	50
2	0	0	8	58	18	2000	5	16	11	22	40
3	0	0	14	57	28	3000	8	9	17	20	30
4	0	0	19	56	35	4000	11	2	23	7	20
5	0	0	24	55	44	5000	1	25	28	54	10
6	0	0	29	54	53	6000	4	18	34	41	0
7	0	0	34	54	2	7000	7	11	40	27	50
8	0	0	39	53	10	8000	10	4	46	12	40
9	0	0	44	52	19	9000	0	27	52	1	29
10	0	0	49	51	28	10000	3	20	57	48	19
20	0	1	29	42	56	20000	7	11	55	36	39
30	0	2	29	34	24	30000	11	2	53	24	58
40	0	3	19	25	52	40000	2	23	51	13	18
50	0	4	9	17	21	50000	6	14	49	1	27
60	0	4	59	8	49	60000	10	5	46	49	57
70	0	5	49	0	17	70000	1	26	44	38	16
80	0	6	38	41	45	80000	5	17	42	26	55
90	0	7	28	43	13	90000	9	8	40	14	55
100	0	8	18	34	41	100000	0	29	38	3	14
200	0	16	37	9	22	200000	1	29	16	5	29
300	0	24	55	44	3	300000	2	23	54	9	43
400	1	3	14	18	41	400000	5	13	52	12	57
500	1	11	32	13	25	500000	4	28	10	16	11
600	1	19	51	28	6	600000	5	27	48	19	26
700	1	28	10	2	47	700000	6	27	26	22	40
800	2	6	28	37	28	800000	7	27	4	25	64
900	2	14	47	12	9	900000	8	26	42	39	8
1000	2	23	5	45	50	1000000	9	26	20	32	23

Drops 10' 15' 45' 16'.

1111

GURU, DR. VRIHASPATI PHALA.

Sup. Mean Anomaly.												
		+ 6° - VI			+ 12° - VII			+ 18° - VIII				
0	0	0	0	0	2	33	11	4	26	0	30	0
3	45	0	20	35	2	52	8	4	35	13	23	12
7	30	0	41	0	3	3	19	4	43	18	22	30
11	15	1	1	8	3	23	40	4	50	10	18	45
15	0	1	20	57	3	38	4	4	55	49	15	0
18	45	1	40	16	3	53	32	5	0	13	11	15
22	30	1	59	10	4	4	5	5	3	27	7	30
26	15	2	17	23	4	15	36	5	5	20	3	45
30	0	2	35	11	4	29	0	5	5	58	0	0
		- XI° + VI			- X° + IV			- IX° + III				
Sup. Mean Anomaly.												

The Argument is found by subtracting Jupiter's corrected mean place, from the place of his Apis.

TABLE of JUPITER'S ANNUAL EQUATION, and CHILIA CARNA. *The Argument of this Table is found by subtracting Jupiter's mean place corrected, from the Sun's mean place corrected.*

2111

Commutation.													
		+ 0		+ I		+ II		+ III		+ IV		+ V	
		Equation.	Chila carna	Equation.	Chila carna	Equation.	Chila carna	Equation.	Chila carna	Equation.	Chila carna	Equation.	Chila carna
0	0	0 0 0	4107	4 48 49	4040	8 55 14	3827	11 18 20	3506	10 50 57	3152	6 46 59	2671
3	45	0 36 43	4107	5 23 3	4021	9 20 13	3791	11 23 47	3461	10 32 23	3110	6 2 3	2847
7	30	1 13 24	4104	5 56 32	3999	9 43 25	3734	11 30 18	3417	10 10 34	3070	5 14 57	2825
11	15	1 50 1	4099	6 29 0	3976	10 4 42	3716	11 31 44	3379	9 45 3	3032	4 25 41	2807
15	0	2 20 28	4092	7 0 38	3951	10 23 54	3676	11 30 7	3326	9 16 2	2995	3 14 30	2793
18	45	3 2 36	4083	7 31 4	3922	10 41 4	3635	11 25 25	3282	8 43 45	2961	2 42 8	2782
22	30	3 38 19	4071	8 0 53	3892	10 55 58	3593	11 17 15	3238	8 7 43	2928	1 48 37	2773
26	15	4 13 47	4056	8 28 39	3860	11 8 29	3550	11 5 50	3195	7 28 35	2898	0 54 34	2770
30	0	4 48 49	4040	8 55 14	3827	11 18 20	3506	10 50 57	3152	6 46 59	2871	0 0 0	2769
		Equation.	Chila carna	Equation.	Chila carna	Equation.	Chila carna	Equation.	Chila carna	Equation.	Chila carna	Equation.	Chila carna
		— XI		— X		— IX		— VIII		— VII		— VI	

Commutation.

TABLE XLIV.

P L

Of the mean motion of Venus, for days.

Days.	Mean motion.					Days.	Mean motion.				
	°	'	"	'''	''''		°	'	"	'''	''''
1	0	1	35	7	44	1000	5	19	8	47	1
2	0	3	12	15	27	2000	10	24	17	35	2
3	0	4	43	23	11	3000	4	6	20	21	4
4	0	6	23	30	54	4000	9	13	33	8	5
5	0	8	0	33	38	5000	3	0	43	55	7
6	0	9	56	46	22	6000	2	12	52	41	8
7	0	11	12	54	5	7000	1	23	1	29	9
8	0	12	49	1	49	8000	7	7	10	16	11
9	0	14	25	9	33	9000	0	19	19	3	12
10	0	16	1	17	16	10000	6	1	27	50	14
20	1	2	2	34	22	20000	0	2	55	40	27
30	1	18	3	51	49	30000	6	4	23	30	41
40	2	4	3	9	5	40000	0	5	31	20	54
50	2	20	6	26	21	50000	6	7	19	11	6
60	3	6	7	43	37	60000	0	8	47	1	21
70	3	22	9	0	53	70000	6	10	14	51	55
80	4	8	19	18	10	80000	0	11	42	41	38
90	4	24	11	35	26	90000	0	13	10	32	2
100	5	10	12	32	42	100000	0	14	38	22	16
200	10	20	25	45	24	200000	0	29	16	44	31
300	4	0	38	38	6	300000	1	13	53	6	47
400	9	10	51	30	49	400000	1	23	33	29	2
500	2	21	4	23	31	500000	2	13	11	51	12
600	8	1	17	16	13	600000	2	27	50	13	31
700	1	11	30	8	53	700000	3	12	28	55	49
800	6	21	43	1	57	800000	3	27	6	52	5
900	0	1	55	54	19	900000	4	11	45	20	20
1000	5	12	8	47	1	1000000	4	25	32	42	25

Days 8' 23' 20' 19'.

9 II.
SUCRA PIALA.

Argument.													
		+ 0 - VI.				+ I - VII.				+ II - VIII.			
0	0	0	0	0	0	24	35	1	52	6	30	0	
3	45	0	7	28	1	0	46	1	25	5	26	15	
7	30	0	14	43	1	8	19	1	37	44	22	39	
11	15	0	22	0	1	16	25	1	39	36	18	45	
15	0	0	29	2	1	15	13	1	41	47	15	0	
18	45	0	35	52	1	23	47	1	43	11	12	18	
22	30	0	42	20	1	24	36	1	45	15	7	30	
26	15	0	48	49	1	28	41	1	46	20	3	45	
30	0	0	54	65	1	32	6	1	48	3	0	0	
		- XI + V.				- X + IV.				- IX + III.			
Argument.													

* The Argument is found by subtracting the Sun's corrected place, from the place of Venus' Apuls.

TABLE of VENUS' ANNUAL EQUATION, and CHILIA CARNA. The Argument of this Table is found by subtracting the Sun's mean place corrected, from Venus' mean place corrected.

214.

Commutation.																	
		+ III		+ IV		+ V		+ VI		+ VII		+ VIII		+ IX			
		Equation.	Chila carnis	Equation.	Chila carnis	Equation.	Chila carnis	Equation.	Chila carnis	Equation.	Chila carnis	Equation.	Chila carnis	Equation.	Chila carnis	Equation.	Chila carnis
0	0	0 0 0	5940	12 33 19	5734	24 43 39	5154	35 53 52	4213	44 27 30	3372	14 16 37	1786	30	0		
3	45	1 34 48	5936	14 6 13	5681	16 10 42	5056	37 6 55	1107	45 9 17	2916	42 31 20	1620	26	11		
7	30	3 9 23	5925	15 38 50	5629	27 38 23	4951	38 21 4	2970	46 44 45	2750	40 7 59	1481	22	26		
11	16	4 44 0	5909	17 11 18	5558	20 5 34	4846	39 32 9	3628	46 9 56	2213	36 45 59	1341	18	45		
15	0	6 18 17	5886	18 42 21	5487	30 37 32	4734	40 39 6	3684	46 23 6	2434	37 14 13	1213	15	0		
19	45	7 52 11	5857	20 14 13	5412	31 51 24	4617	41 43 3	3336	46 3 48	2106	18 47 30	1013	7	20		
23	50	9 25 1	5823	21 44 40	5331	33 12 47	4496	42 45 41	3385	45 28 17	1945	9 51 15	956	3	43		
26	15	10 59 27	5781	23 14 25	5244	34 33 7	4371	43 28 56	2231	44 27 30	3073	14 16 37	1786	0	0		
30	0	12 33 19	5734	24 43 32	5152	35 51 52	4241	44 27 30	3073	14 16 37	1786	0 0 0	936	0	0		
		Equation.	Chila carnis	Equation.	Chila carnis	Equation.	Chila carnis	Equation.	Chila carnis	Equation.	Chila carnis	Equation.	Chila carnis	Equation.	Chila carnis		
		— XI.		— X.		— IX.		— VIII.		— VII.		— VI.					
Commutation.																	

TABLE XLV.

h 1.

Of Saturn's mean motion for days.

Days.	Mean motion.					Days.	Mean motion.				
	s	'	"	'''	''''		s	'	"	'''	''''
1	0	0	2	0	23	1000	1	3	26	21	30
2	0	0	4	0	46	2000	2	6	52	43	1
3	0	0	6	1	0	3000	3	10	19	4	31
4	0	0	8	1	32	4000	4	13	45	26	2
5	0	0	10	1	54	5000	5	17	11	47	32
6	0	0	12	2	17	6000	6	20	38	9	3
7	0	0	14	2	40	7000	7	24	4	30	33
8	0	0	16	3	13	8000	8	27	30	52	4
9	0	0	18	3	36	9000	10	0	57	13	34
10	0	0	20	3	49	10000	11	4	23	35	5
20	0	0	40	7	38	20000	10	8	47	10	10
30	0	1	0	11	27	30000	9	13	10	45	15
40	0	1	20	15	16	40000	8	17	34	30	20
50	0	1	40	19	5	50000	7	21	57	55	25
60	0	2	0	22	53	60000	6	26	31	30	30
70	0	2	20	26	42	70000	5	0	45	5	35
80	0	2	40	30	31	80000	5	5	8	40	40
90	0	3	0	24	20	90000	4	9	32	15	44
100	0	3	20	28	9	100000	3	13	55	50	49
200	0	6	41	16	18	200000	6	27	51	41	59
300	0	10	1	51	27	300000	10	11	47	38	28
400	0	13	22	32	36	400000	1	25	43	23	18
500	0	16	43	10	45	500000	5	0	39	14	7
600	0	20	3	48	54	600000	8	23	35	4	56
700	0	23	24	27	3	700000	0	7	30	55	46
800	0	26	43	2	12	800000	3	21	24	46	35
900	1	0	5	48	21	900000	7	5	24	57	25
1000	1	3	26	51	30	1000000	10	19	18	28	14

Drops R 25' 53' 32".

७ II.
SANT PRALA.

Sep. Mean Anomaly.												
		+ 0° - VI°			+ 1° - VII°			+ 2° - VIII°				
°	'	°	'	°	°	'	°	'	°	'	°	'
0	0	0	0	0	3	51	37	6	58	55	30	0
3	45	0	20	35	4	17	10	6	52	51	25	15
7	30	1	0	37	4	41	36	7	5	9	22	30
11	15	1	30	37	5	4	45	7	15	31	18	45
15	0	2	0	20	5	28	33	7	24	5	15	0
18	45	2	20	20	5	47	0	7	30	45	11	15
22	30	2	57	35	6	5	56	7	25	38	7	30
26	15	3	25	1	6	23	14	7	38	35	3	45
30	0	3	51	37	6	33	56	7	39	31	0	0
		- XI° + V°			- X° + IV°			- IX° + III°				
Sep. Mean Anomaly.												

The Argument is found by subtracting Saturn's corrected mean place, from the place of his Apis.

TABLE of SATURN'S ANNUAL EQUATION, and CHILIA CARNA. *The Argument of this Table is found by subtracting Saturn's mean place corrected, from the Sun's mean place.*

b. III.

Computation.																											
+ O.				+ I.				+ II.				+ III.				+ IV.				+ V.							
Equation.		Data.		Equation.		Data.		Equation.		Data.		Equation.		Data.		Equation.		Data.		Equation.		Data.					
a	b	c	d	e	f	g	h	i	j	k	l	m	n	o	p	q	r	s	t	u	v	w	x	y	z		
0	0	0	0	3811	2	52	2	3769	5	11	35	3643	6	20	21	3459	5	47	52	3265	3	28	2	3117	30	0	
3	48	0	22	2	3810	3	12	1	3738	5	24	40	3623	6	22	20	3434	5	35	50	3242	3	4	25	3104	26	15
7	30	0	44	3	3809	3	31	23	3743	5	36	52	3601	6	22	36	3400	5	22	19	3221	2	39	52	3092	22	30
11	18	1	6	0	3808	3	20	0	3733	5	47	37	3529	6	21	0	3384	5	7	0	3200	2	14	31	3083	18	42
15	0	1	27	47	3801	4	8	11	3710	5	37	3	3556	6	17	59	3369	4	50	4	3181	1	48	26	3077	16	0
18	42	1	49	19	3795	4	23	27	3690	6	5	7	3534	6	13	7	3335	4	51	30	3162	1	21	40	3072	11	15
22	30	2	10	33	3788	4	41	50	3658	6	11	45	3509	6	6	29	3313	4	11	49	3140	0	54	41	3062	7	33
26	15	2	31	29	3779	4	27	13	3663	6	16	51	3484	5	53	2	3289	3	50	29	3131	0	27	23	3065	3	45
30	0	2	52	2	3769	5	11	35	3643	6	26	21	3459	5	47	52	3265	3	28	2	3117	0	0	0	3063	0	0
Equation.		Data.		Equation.		Data.		Equation.		Data.		Equation.		Data.		Equation.		Data.		Equation.		Data.					
— XI.				— X.				— IX.				— VIII.				— VII.				— VI.							
Computation.																											

TABLE XLVI.

Showing the *Lagna*, *Chara Cumula*, and *Ullagna* for every Sign of the *Ecliptic*; calculated for the Latitude of $16^{\circ} 45'$; being that of *Banda*, near *Masulipatam*; to which the Commentary refers.

	— I and IV Quadrants.			+ II and III Quadrants.		
	I st or XII th	II nd or XI th	III rd or X th	IV th or X th	V th or VIII th	VI th or VII th
<i>Lagna</i>	1670'	1795'	1935'	1925'	1795'	1670'
<i>Chara Cumula</i>	298	169	70	70	169	298
<i>Ullagna</i>	1462	1625	1803	2003	1904	1872

For the Sun's Declination, Right Ascension, and Amplitude, when his Longitude is I, II, and III Signs. See Text, page 97, 98, 101, and 102.

TABLE XLVII. (*)

Being the 4th of the *Vulturn* process.

For reducing the Moon's place as computed for the time of Sun rising at *Lanca*, to what it is at a similar instant at another place, stated to be *Trivaltara* near *Tanjore*, the Longitude of which is $3^{\circ} 48' 45''$ East of *Lanca*, and Latitude $10^{\circ} 41'$ N. Communicated by *Sami Nada Saahib* of *Pondicherry*.

Hindu names of Solar months.	Tamil names of Solar months.	Desen- tations ca- las. +	Andra vica- las for any day in the same month.
८ Vaisācha	Chaitram	15'	— 12'
९ Jyeshtha	Vyasaai	10	— 10
१० A'shād'hā	Audi	7	— 6
११ Śrāvana	Audi	8	+ 2
१२ Bhādrapada	Anuadi	11	+ 5
१३ A'svina	Parvati	17	+ 12
१४ Kartika	Arpadi	21	+ 8
१५ Mārgasīras	Kartika	28	+ 14
१६ Pāusha	Margali	30	— 4
१७ Māgha	Tyā	29	— 2
१८ Pūshyāmasa	Maasi	26	— 6
१९ Chaitra	Poonngudi	21	— 10

The *Desentara* calas are always addi- tive; and are to be taken for the month which precedes that for which the com- putation is made.

The *andra vicālas* are for any day in the month the computation is made for. They are to be used as multiples of the odd degrees, minutes and seconds of the Sun's true place or *Sputa Graha*, at Sun rising on the given day; the product of the degrees giving *vicālas* or seconds; that of the minutes, *torpāras* or thirds, and so forth.

This latter Equation is to be applied + to the Moon's uncorrected place, as indicated in the Table.

EXAMPLE.

Let the Sun's *Sputa Graha* or true place in the Hindu Zodiac on the 24th Audi complete (or 25th at Sun rising) be

2 22 59 3

And the *D's* uncorrected place at the same instant

4 3 57 13

1st Desentara calas for the month Audi

+ 7 0

2nd The *andra vicālas* (col. 3) for any day in Audi are + 2. The odd degrees of the Sun's Longitude are

22° 59' 3"

therefore $\times 2$

45° 58' 6" or say + 46

D's place corrected for Desentara, 24th Audi

4 4 4 59

There only remains the Equation of the *Arca Bhagābala* to be applied to the Moon's corrected place, to have her *Sputa Graha* or true place, at Sun rise on the 25th Audi, at the place computed for.

N. B.—The common *Kalendar* makers use indiscriminately the above Table for any place in these South Eastern Provinces.

(*) This Table is accidentally inserted out of its place; it should be the XLVIIIth.

TABLE XLVIII.

For the Solar Abargana from the beginning of the Kali yug, the mean Solar Sydercal year being $\frac{1211111111}{41250000}$ or 3654 12s 31r 31p 24r.

First Part, according to the Sarrish Siddhanta.

Years.	Time due to corresponding periods.	Years.	Time due to corresponding periods.	Name of Solar months according to the Sarrish Siddhanta.	Time due to each month.
	D. G. V. P. S.		D. G. V. P. S.		D. G. V. P. S.
1	365 13 31 31 24	100	36525 52 32 20	Sarrish Siddhanta (separately).	
2	730 31 2 2 48	200	73051 43 4 40	Māsa m.	30 55 32 2 33
3	1095 48 34 34 12	300	109577 37 37 0	Vēśā m.	31 24 12 2 41
4	1461 2 6 5 36	400	146103 30 9 20	Māṭhānā m.	31 56 38 2 44
5	1826 17 37 37 0	500	182629 22 41 40	Carēṭā m.	31 28 12 2 42
6	2191 33 9 8 24	600	219155 15 14 0	Ṭiṇḥā m.	31 2 10 2 40
7	2556 48 40 39 48	700	255681 7 46 20	Carvā m.	30 27 22 2 39
8	2922 4 12 11 12	800	292207 0 13 40	Ṭulā m.	29 54 7 2 35
9	3287 19 43 42 36	900	328734 52 31 0	Vēśāḥ m.	29 30 24 2 33
10	3652 35 13 14 0	1000	365258 45 23 20	Ḍharmā m.	29 20 23 2 31
20	7305 10 30 28 0	2000	730517 30 46 40	Māṣā m.	29 27 16 2 30
30	10957 45 45 42 0	3000	1095776 16 10 0	Camḥā m.	29 48 24 2 33
40	14610 2 0 56 0	4000	1461035 1 33 20	Mīn m.	30 20 21 2 36
50	18262 36 16 10 0	5000	1826293 46 16 40	End of each month.	
60	21915 31 31 24 0	6000	2191552 34 20 0	Vaisāḥ	30 55 32 2 39
70	25568 6 46 38 0	7000	2556811 17 43 20	Jyēṣṭhā	32 19 44 5 20
80	29220 42 1 52 0	8000	2922070 3 6 40	Aśvīn	33 25 22 8 4
90	32873 17 17 6 0	9000	3287328 48 39 0	Śrāvān	125 24 34 10 46
100	36525 52 32 20 0	10000	3652587 33 53 20	Bhādrapada	155 26 44 13 20

For the Solar Abargana from the beginning of the Kali yug, the mean Solar Sydercal year being $\frac{1211111111}{41250000}$ or 3654 15s 31r 15p. (*)

Second Part, according to the Aris Siddhanta.

Years.				Time of corresponding periods.				Years.				Time of corresponding periods.				Arid Siddhanta (separately).				
				D. G. V. P.								D. G. V. P.								
1	365	15	31	12	100	36525	52	5	Chaitra	Y	30	55	32	1	Chaitra	Y	30	55	32	1
2	730	31	2	30	200	73051	44	10	Vyāśa	3	31	24	12	1	Vyāśa	3	31	24	12	1
3	1095	48	33	45	300	109577	38	15	Āmī	4	31	36	38	1	Āmī	4	31	36	38	1
4	1461	2	5	0	400	146103	28	20	Āmī	5	31	28	12	2	Āmī	5	31	28	12	2
5	1826	17	30	15	500	182629	20	25	Āmī	6	31	2	10	1	Āmī	6	31	2	10	1
6	2191	33	7	30	600	219155	12	30	Parāṣṭī	7	30	27	22	1	Parāṣṭī	7	30	27	22	1
7	2556	48	38	45	700	255681	4	35	Arṣṭī	8	29	54	7	1	Arṣṭī	8	29	54	7	1
8	2922	4	10	0	800	292203	56	40	Cartiga	9	29	30	24	2	Cartiga	9	29	30	24	2
9	3287	19	41	15	900	328732	48	45	Margāḥ	10	29	20	23	1	Margāḥ	10	29	20	23	1
10	3652	35	12	30	1000	365258	40	50	Tye	11	29	27	16	1	Tye	11	29	27	16	1
20	7305	10	25	0	2000	730517	21	40	Māṣā	12	29	48	24	1	Māṣā	12	29	48	24	1
30	10957	45	37	30	3000	1095776	2	50	Poonḡonī	13	30	20	21	2	Poonḡonī	13	30	20	21	2
40	14610	20	50	0	4000	1461034	43	20	(Collectively) End of each month.											
50	18262	36	2	30	5000	1826293	24	10	Chaitra	Y	30	55	32	1	Chaitra	Y	30	55	32	1
60	21915	31	15	6	6000	2191552	5	0	Vyāśa	3	31	24	12	1	Vyāśa	3	31	24	12	1
70	25568	6	27	30	7000	2556810	45	50	Āmī	4	31	36	38	1	Āmī	4	31	36	38	1
80	29220	41	40	0	8000	2922069	56	40	Āmī	5	31	28	12	2	Āmī	5	31	28	12	2
90	32873	16	52	30	9000	3287328	7	50	Āmī	6	31	2	10	1	Āmī	6	31	2	10	1
100	36525	52	5	0	10000	3652580	48	20	Parāṣṭī	7	30	27	22	1	Parāṣṭī	7	30	27	22	1

(*) The same Solar year according to the copies of the Aris Siddhanta preserved in Bengal, is $\frac{1211111111}{41250000}$ or 3654 15s 31r 15p 17r. This year is unknown in the Peninsula.

Chaitram	८	30	55	32	1
Vyāśā	८	31	24	12	1
Āmī	८	31	36	38	1
Āmī	८	31	28	12	2
Āmī	८	31	2	10	1
Parāṣṭī	८	30	27	22	1
Arṣṭī	८	29	54	7	1
Cartiga	८	29	30	24	2
Margāḥ	८	29	20	53	1
Tye	८	29	27	16	1
Māṣā	८	29	48	24	1
Poonḡonī	८	30	20	21	2
(Collectively) End of each month.					
Chaitram	८	30	55	32	1
Vyāśā	८	32	19	44	2
Āmī	८	33	25	22	3
Āmī	८	125	24	34	5
Āmī	८	155	26	44	6
Parāṣṭī	८	160	24	6	7
Arṣṭī	८	216	48	15	8
Cartiga	८	246	18	37	10
Margāḥ	८	275	39	30	11
Tye	८	305	6	40	12
Māṣā	८	334	55	10	13
Poonḡonī	८	365	15	31	15

TABLE XLIX.

For the Luni-solar *Ahargana*, from the beginning of the *Calī yug*, the mean Lunation being
 $29\frac{53}{100}$ or $294\ 31\frac{30}{100}$ or $59,78$.

First Part, according to the *Sūryah Siddhanta*. (*)

Years.	Time due to corresponding periods.					Years.	Time due to corresponding periods.					Luna- tion.	Time due to the end of the respective mean Lunar months.				
	D.	G.	V.	P.	S.		D.	G.	V.	P.	S.		D.	G.	V.	P.	S.
1	554	24	1	33	57,14	100	55436	42	10	53	14		29	31	50	6	59,78
2	708	44	2	47	54,28	200	70873	24	39	50	28	1	59	2	40	13	59,56
3	1063	0	4	11	51,42	300	106310	9	59	45	42	2	88	23	30	20	59,34
4	1417	28	5	32	48,56	400	141746	49	19	40	56	3	118	7	20	27	59,12
5	1771	50	6	59	45,70	500	177183	31	39	30	10	4	147	39	10	34	58,90
6	2126	12	8	23	42,84	600	212620	13	59	31	24	5	177	11	0	41	58,68
7	2480	34	9	47	39,98	700	248056	56	12	20	38	6	206	42	50	48	58,46
8	2834	56	11	11	37,12	800	283493	39	39	21	52	7	236	14	40	55	58,24
9	3189	16	12	33	34,26	900	318930	20	59	17	6	8	265	46	31	2	58,01
10	3543	40	13	59	31,40	1000	354367	3	12	12	20	9	295	18	21	9	57,80
20	7087	60	27	59	2,8	2000	708734	6	38	24	40	10	324	50	11	15	57,56
30	10631	0	41	58	34,2	3000	1063101	9	57	37	0	11	354	22	1	23	57,30
40	14174	40	55	58	3,6	4000	1417468	13	10	49	20	12	383	53	51	30	57,14
50	17718	21	9	57	37,0	5000	1771835	16	36	1	40	13					
60	21262	4	23	57	8,4	6000	2126202	19	56	14	0						
70	24805	41	37	56	39,8	7000	2480569	22	14	28	20						
80	28349	21	51	56	11,2	8000	2834936	25	23	28	40						
90	31893	2	6	55	42,6	9000	3189303	29	52	51	0						
100	35436	42	16	55	14,0	10000	3543670	32	12	3	20						

For the Luni-solar *Ahargana* from the beginning of the *Calī yug*, the mean Lunation being
 $29\frac{53}{100}$ or $294\ 31\frac{30}{100}$ or $59,78$.

Second Part, according to the *Arīa Siddhanta*.

Years.	Time due to corresponding periods.					Years.	Time due to corresponding periods.					Luna- tion.	Time due to the end of the respective mean Lunar months.				
	D.	G.	V.	P.	S.		D.	G.	V.	P.	S.		D.	G.	V.	P.	S.
1	554	22	1	8	2,6	100	55436	41	53	24	20		29	31	50	5	40,21
2	708	44	2	16	6,2	200	70873	23	46	48	40	1	59	2	40	11	20,43
3	1063	6	3	24	7,8	300	106310	3	40	13	0	2	88	23	30	17	0,63
4	1417	28	4	32	10,4	400	141746	47	33	37	20	3	118	7	20	23	40,84
5	1771	50	5	40	13,0	500	177183	29	27	1	40	4	147	39	10	28	21,06
6	2126	12	6	48	15,6	600	212620	11	29	20	0	5	177	11	0	34	1,28
7	2480	34	7	50	18,2	700	248056	33	13	20	20	6	206	42	50	39	41,50
8	2834	56	9	4	20,8	800	283493	36	7	14	40	7	236	14	40	45	21,72
9	3189	16	10	12	23,4	900	318930	17	0	39	0	8	265	46	30	51	1,94
10	3543	40	11	20	26,0	1000	354367	23	54	3	20	9	295	18	20	50	42,16
20	7087	60	22	40	52,0	2000	708733	57	48	6	40	10	324	50	11	2	22,38
30	10631	0	34	1	18,0	3000	1063100	56	42	10	0	11	354	22	1	8	2,60
40	14174	40	45	21	44,0	4000	1417467	53	36	13	20	12	383	53	51	13	42,82
50	17718	20	10	43	10,0	5000	1771834	54	20	16	40	13					
60	21262	1	8	2	36,0	6000	2126201	53	14	20	0						
70	24805	41	19	23	2,0	7000	2480568	52	16	23	20						
80	28349	21	30	43	28,0	8000	2834935	51	12	20	40						
90	31893	1	42	3	54,0	9000	3189302	50	6	30	0						
100	35436	41	23	24	50,0	10000	3543669	49	0	33	20						

(*) The *Pandita* Astronomers, Tulluṅga as well as Tanaḥ, invariably use in their computations the Solar *Ahargana* according to the *Arīa*, and the Lunar according to the *Sūryah Siddhanta*.

USE and APPLICATION of TABLES XLVIII and XLIX.

TABLE XLVIII.

EXAMPLE I.

1^o Wanted the Solar Ahargana for the beginning of the Solar year 4024 of the Cali yug, or 4023 complete, (A. D. 1822), according to the Surrish Siddhanta.

	Y.	D.	G.	V.	P.
By Table XLVIII, part 1, we have for 4000	-	1461035	1	23	30
200	-	318732	52	51	0
20	-	7305	10	30	18
3	-	1095	46	34	31

		1798168	51	29	22
Subtract <i>Sodhyan</i> , or constant Equation	-	-	2	8	51 15

Ahargana, 1st Vaisâcha γ , which divide by 7)1798168 (42 38 7

Remainder 6 which counted from

Friday, gives Soota dina *Thursday*.

2^o Wanted the Ahargana for the 1st of Vrischika mass, or Bengal Mârgasira, of the same year.

	D.	G.	V.	P.
Ahargana for 1st Vaisâcha, above found	1798168	42	38	7
Add collective number of days registered in the last column down to Cartiga	216	48	12	19

Ahargana, 1st Mârgasira π , which divide by 7)1798383 (25 51 20

Remainder 6 which counted as usual

from Friday, gives Soota dina *Thursday*.

EXAMPLE II.

1^o Wanted the same, according to the Aria Siddhanta.

	Y.	D.	G.	V.	P.
By Table XLVIII, part 2, we have for 4000	-	1461034	43	20	0
200	-	318732	48	45	0
20	-	7305	19	23	0
3	-	1095	46	23	43

		1798168	29	3	45
Subtract <i>Sodhyan</i> :	-	-	2	8	51 15

Ahargana, 1st Chaitram γ , which divide by 7)1798166 (25 12 30

Remainder 6 which counted from

Friday, gives Soota dina *Thursday*.

But here the Civil beginning by the respective accounts will differ, on account of the fraction of days, which by the Surrish Siddhanta is 42 38 7 $\frac{1}{2}$, exceeding 30; and by the Aria Siddhanta 25 12 30 $\frac{1}{2}$ below 30. Hence the feria of the first Civil day in the year will be, viz. by the Surrish, *Friday*; and by the Aria, *Thursday*.

2^o Wanted the Ahargana for the 1st Cartiga (Tamil denomination) of the same year.

	D.	G.	V.	P.
Ahargana for 1st Chaitram, above found	1798166	20	12	20
Add collective number of days registered in the last column down to Arpaal	216	48	12	8

Same Ahargana, as by the Surrish Siddhanta - 1798383 2 23 38
subject to the same difference of Civil reckoning.

TABLE XLIX.

EXAMPLE I.

1^o Wanted the Luni-solar Ahargana according to the Sarriah Siddhanta, for the end of the 4923d year of the Cali yug. The Solar Ahargana for the beginning of the year 4924 being 1798166⁴ 42² 33⁷ 7p.

Use Solar Ahargana as
as an Index.

	B.	By Table XLIX, part 1, column 2, for	T.	D.	S.	V.	P.	S.
4924	-	4000	-	1417468	13	16	49	20
(1)	-	900	-	518930	20	59	17	6
	-	20	-	7087	20	27	59	3
	-	3	-	1063	6	4	11	51
	-							
(2)	-	33617						
	-	35436						
	-	18181						
(3)	-	17718						
	-	463						
(4)	-	354						
	-	109						
(5)	-	88						

Remainder 2² which neglect. Luni-solar Ahargana sought 1798148
and for the Soota dina, or day of conjunction
7)1798148²(256878 weeks.

Remainder 2² counted from Thursday, gives *Saturday*.

EXAMPLE II.

2^o The same, according to the Arie Siddhanta.

The Solar Ahargana is
the same as in the pre-
ceding article as to the
number of days. The
same Index might there-
fore serve.

	B.	By Table XLIX, part 2, column 2, for	T.	D.	S.	V.	P.	S.
4924	-	4000	-	1417467	53	30	13	20
(1)	-	900	-	518930	17	0	39	0
	-	20	-	7087	20	22	40	52
	-	3	-	1063	6	3	24	7,9
	-							
	-	33618						
(2)	-	35436						
	-	18182						
(3)	-	17718						
	-	464						
(4)	-	354						
	-	110						
(5)	-	88						
	-	22						

Proceeding as in Example I, for the Soota dina, it will be
found to fall on *Friday*.

N. B.—The Tamil Astronomers, though computing in *Solar time*, use in preference the Luni-
solar Ahargana according to the Sarriah Siddhanta: and for the Solar, the *Arie Siddhanta*.

TABLE I.

This Table shews the Root or Character of every month in the Mahomedan year, according as that of Mahorum is 1, 2, 3, 4, 5, 6, or 7. It is therefore always to be entered with the Root given in Table I.

	Names of the months.	Number of days in each month.	Roots.						
			1	2	3	4	5	6	7
1	Mahorum	30	1	2	3	4	5	6	7
2	Sepher, or Suffer	29	3	4	5	6	7	1	2
3	Rabi-el-Avul	30	4	5	6	7	1	2	3
4	Rabi-el-Ankeer	29	6	7	1	2	3	4	5
5	Glumadi; or } Glumasil } el-Avul	30	7	1	2	3	4	5	6
6	Glumadi; or } Glumasil } el-Ankeer	29	2	3	4	5	6	7	1
7	Rogeb; or Reghab	30	3	4	5	6	7	1	2
8	Shahaban	29	5	6	7	1	2	3	4
9	Ramazan; or Rhamadan	30	6	7	1	2	3	4	5
10	Shawal	29	1	2	3	4	5	6	7
11	Zoolcade; or Zoolcayadah	30	2	3	4	5	6	7	1
12	Zoolledge; or	C 29	4	5	6	7	1	2	3
	Zoolcagladah	B 30							

N. B.—The month of Zoolledge, consists of 29 or 30 days, according as the year is a common or an intercalary one.

Table LI helps to determine what Hindu Solar year concurs at its beginning with any proposed year of the Hejira; and inversely to indicate, in what year of the Hejira any proposed Solar year happens to begin.

Thus any Hindu Solar year commencing between A. Hejira 1 and 81 has for limits, the 16th (one day less than the 18th, registered in the 3d column of the second Section of Table LI), and the 21st (one day more than the 20th), March of its concurrent European year, Julian style.

Any Hindu Solar year falling between the 900th and 1000th year of the Hejira cannot commence earlier than the 26th (one day less than the 27th), and later than the 28th (one day more than the 27th), of March, Old style; or before the 6th and after the 7th April, New style.

TABLE LI.

Exhibiting the respective beginnings of the Hejira, and Hindu Solar, concurrent with European Secular years.

Years of Hejira concurrent with European Secular years.		Hindu Solar years concurrent with European Secular years.				Christian Secular years.
Anno Hejira.	Epoch of beginning.	Anno Calliyugam.	Year of Salivahana or Saca.	Beginning of Hindu Solar year in March.	Beginning of Hindu Solar year in April.	
				O. S.	N. S.	
1	16 July	3724	545	19	"	* 632
81	26 February	3802	623	20	"	700
181	1 February	3902	723	20	"	800
287	1 January	4002	823	21	"	900
288	26 December					
391	1 December	4102	923	22	"	1000
491	6 November	4202	1023	23	"	1100
597	12 October	4302	1123	23	"	1200
703	10 September	4402	1223	25	"	1300
803	23 August	4502	1323	26	"	1400
906	28 July	4602	1423	27	6	1500
	O. S. N. S.					
1000	3 July 13 July	4702	1523	27	6	1600
1112	7 " 18 June	4802	1623	28	6	1700
1215	13 " 25 May	4902	1723	29	10	1800
1318	18 April 1 May	5002	1823	30	12	1900

TABLE LII.

PART THE FIRST.

Shewing the Sun's mean Longitude on the 1st of January of each Secular year of the Julian Calendar, from A. A. C. 4000 to A. D. 4000, constructed by means of Delalande's Solar Tables I and II (Edition of 1754) for noon time under the Meridian of Paris.

I.		II.		III.		IV.	
Years before Christ.		Years after Christ.		☉'s motion for Bissextile years.		☉'s motion for 4 years either ascending or descending.	
Solar Julian Secular years.	☉'s mean motion.	Solar Julian Secular years.	☉'s mean motion.	Year.	☉'s mean motion.		
	<i>h. m. s.</i>		<i>h. m. s.</i>		<i>h. m. s.</i>	Years ascending.	
4000	8 7 19 59	0	9 7 57 5	4	1 50,23	1st Common year	— 44 43',6
3000	8 14 50 15	100	9 8 43 1	8	3 40,43	2d do. do.	— 30 29,3
2000	8 22 38 32	200	9 9 28 56	12	5 30,68	3d do. do.	— 16 9,8
1000	8 29 24 27	300	9 10 14 52	16	7 20,90	4th Bissextile	— 1 59,2
1800	8 21 10 23	400	9 11 0 43	20	9 11,13	Years descending.	
1700	8 24 56 19	500	9 11 46 43	24	11 1,36	1st Com. year.	+ 11 29 45' 40",5
1600	8 25 42 14	600	9 12 32 39	28	12 51,58	2d do. do.	+ 11 29 31 21,0
1500	8 26 28 10	700	9 13 18 35	32	14 41,80	3d do. do.	+ 11 29 17 1,5
1400	8 27 14 6	800	9 14 4 30	36	16 32,03	4th Bissextile.	+ 0 0 1 50,2
1300	8 28 0 1	900	9 14 50 25	40	18 22,26	SUPPLEMENTARY TABLE.	
1200	8 28 45 57	1000	9 15 36 22	44	20 12,49	Collective number of days at the end of each Solar month.	
1100	8 29 31 53	1100	9 16 22 17	48	22 2,72	Bengal names.	Tamul names.
1000	9 0 17 48	1200	9 17 8 13	52	23 52,95		Number of days
900	9 1 3 44	1300	9 17 54 9	56	25 43,17		
800	9 1 49 40	1400	9 18 40 4	60	27 33,40	Vaisācha	Chaitram
700	9 2 35 35	1500	9 19 26 0	64	29 23,63	Jyēṣṭhā	Vyāṣai
600	9 3 21 31	1600	9 20 11 56	68	31 13,86	Aśādhā	Aani
500	9 4 7 27	1700	9 20 57 51	72	33 4,08	Śrāvāna	Andi
400	9 4 53 22	1800	9 21 43 47	76	34 54,30	Bhādrapada	Auvani
300	9 5 39 18	1900	9 22 29 43	80	36 44,53	Aśvina	Paratasi
200	9 6 25 14	2000	9 23 15 38	84	38 34,76	Cartiga	Arpei
100	9 7 11 9	3000	10 0 34 54	88	40 24,99	Margasira	or
0	9 7 57 5	4000	10 8 34 11	92	42 15,21	Agrahayan	Cartiga
		300	9 2 17 46,98	96	44 5,43	Paushia	Margali
		400	9 3 32,04	100	45 55,66	Māgha	Tye
		500	9 4 9 38,30	200	1 31 51,32	P'hal'guna	Maussi
						Chaitra	Poonooni

Application of this Table for finding the Sun's mean Longitude on the 1st January of any Bissextile Julian year, and on the 31st December of any Common year of the same style.

EXAMPLE I.
Wanted the Sun's mean Longitude for A. A. C. 720, a Bissextile.

By col. I A. A. C. 700 9 2 35 55
Col. III for 20 years — 9 11,13
Mean Long. sought 9 2 26 23,87

and the year being a Bissextile one, the Longitude so found is for the 1st January at noon A. A. C. 720.

EXAMPLE II.
Wanted the same for A. D. 542, a common year.

By Col. II A. D. 500, 9 11 46 43,0
Col. III for 40 years, 18 22,26
Col. IV for 2 years, 11 29 31 21,0
Mean Long. sought 9 11 36 20,26

and the year being a Common one, the Longitude so found is for the 31st December 542.

EXAMPLE III.
Wanted the same for A. D. 1815, a Bissextile year.

By Col. II A. D. 1800, 9 21 48 47,0
Col. III for 15 years, 7 20,9
Mean Long. sought 9 21 51 7,9

and the year being a Bissextile one, the Longitude so found is for 1st January A. D. 1815.

TABLE III.

PART THE SECOND.

Shewing the Sun's mean motion for days, hours, minutes and seconds, constructed by means of Delalande's Solar Tables III and IV. (Edition of 1764). The Supplementary Table being for deducing the European monthly date from any number of days elapsed of the Julian year.

I.		II.				III.		IV.		SUPPLEMENTARY TABLE.
Days.	☉'s mean motion.	Hours.	☉'s mean motion.	Mins.	☉'s mean motion.	Seconds.	☉'s mean motion.	Days.		
10	0 50 8,5	1	2 27,8	16	30 25,5	1	0 2,3	1	0,0	Showing the collective number of days elapsed at the end of each European month.
20	1 58 16,7	2	4 55,7	17	41 53,1	2	0 4,9	2	0,1	
30	2 57 25,0	3	7 23,3	18	54 21,2	3	0 7,4	3	0,1	
40	3 45 33,3	4	9 51,4	19	66 49,1	4	0 9,9	4	0,2	January 31
50	4 55 41,6	5	12 19,2	20	79 16,9	5	0 12,3	5	0,2	February 59
60	5 54 50,0	6	14 47,1	21	91 44,8	6	0 14,8	6	0,2	March 90
70	6 53 58,3	7	17 14,9	22	104 12,6	7	0 17,2	7	0,3	April 120
80	7 53 5,6	8	19 42,8	23	116 40,5	8	0 19,7	8	0,3	May 151
90	8 52 15,0	9	22 10,6	24	129 8,3	9	0 22,2	9	0,4	June 181
100	9 51 23,8	10	24 38,5			10	0 24,6	10	0,4	July 212
200	19 42 46,6	11	27 6,3			20	0 49,3	20	0,8	August 243
300	29 34 9,9	12	29 34,2			30	1 13,9	30	1,9	September 273
400	39 25 33,2	13	32 2,0			40	1 38,6	40	1,6	October 304
500	49 16 56,5	14	34 29,9			50	2 3,2	50	2,1	November 334
600	59 8 19,8	15	36 57,7			60	2 27,8	60	2,0	December 365
700	8 59 43,1									N. B.—In Bissextile years, one day is to be added to the respective sums from February downwards.
800	18 51 6,4									
900	28 42 29,7									
1000	38 33 53,0									
2000	6 17 7 48,0									
3000	23 41 39,0									

For an explanation of the first part of this Table and particularly of its 4th column, see *Delalande's Astronomy*, book VI, vol. I, art. 294 and following: the second part is self-evident, and therefore requires no explanation. But as those who may have occasion to

For an explanation of the first part of this Table and particularly of its 4th column, see *Delalande's Astronomy*, book VI, vol. I, art. 204 and following: the second part is self-evident, and therefore requires no explanation. But as those who may have occasion to

use these Tables may not have that work at their disposition, it may be proper to state that for the sake of conveniency they were arranged on the following principle.

If you have the Sun's mean Longitude for any annual Epoch and you want it for the next, add his motion for 365 days, which is $11^{\circ} 29' 45'' 40'''$, if the following be a Common year: but if it be a Leap one, add overmore, the ☉'s mean motion for one day, i. e. $59' 8'' 3'''$, in all $44^{\circ} 48' 3''$: and the Longitude so obtained will be for the 1st January in all *Bissextile*, and for the 31st December in all Common years. The aggregate of 1, 2, 3 and 4 years equation is given in column 4th, part 1st, of this Table, and is to be applied as follows, for descending years.

EXAMPLE IV.

Let the Sun's mean Longitude on the 1st January 1816, be found to be

I. $\begin{array}{r} 9\ 21\ 43\ 47 \\ \text{A. D. } 11\ 29\ 40\ 40,5 \\ 1817 - 9\ 21\ 29\ 27,5 \\ \hline \text{Common} \\ 31\text{st December } 1816. \end{array}$	II. $\begin{array}{r} 9\ 21\ 43\ 47 \\ \text{A. D. } 11\ 29\ 31\ 21 \\ 1818 - 9\ 21\ 15\ 8 \\ \hline \text{Common} \\ 31\text{st December } 1817. \end{array}$	III. $\begin{array}{r} 9\ 21\ 43\ 47 \\ \text{A. D. } 11\ 29\ 17\ 1,5 \\ 1819 - 9\ 21\ 0\ 48,5 \\ \hline \text{Common} \\ 31\text{st December } 1818. \end{array}$	IV. $\begin{array}{r} 9\ 21\ 43\ 47 \\ \text{A. D. } 0\ 0\ 1\ 50,3 \\ 1820 - 9\ 21\ 45\ 37,3 \\ \hline \text{Bisextile} \\ 1\text{st January } 1820. \end{array}$
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On the same principles the Equations for ascending years, such as those before Christ, are to be applied to the Longitude due to the given Epoch with contrary Signs.

EXAMPLE V.

Let the Sun's mean Longitude on the 1st January A. A. C. 720, be (Ex. I.)

I. $\begin{array}{r} 9\ 2\ 26\ 23,87 \\ \text{B. C. } - 44\ 48,8 \\ 721 - 9\ 1\ 41\ 35,07 \\ \hline \text{Common} \\ 31\text{st December } 720. \end{array}$	II. $\begin{array}{r} 9\ 2\ 26\ 23,87 \\ \text{B. C. } - 30\ 20,2 \\ 722 - 9\ 1\ 55\ 34,07 \\ \hline \text{Common} \\ 31\text{st December } 721. \end{array}$	III. $\begin{array}{r} 9\ 2\ 26\ 23,87 \\ \text{B. C. } - 16\ 9,8 \\ 723 - 9\ 2\ 10\ 14,07 \\ \hline \text{Common} \\ 31\text{st December } 722. \end{array}$	IV. $\begin{array}{r} 9\ 2\ 26\ 23,87 \\ \text{B. C. } - 1\ 30,23 \\ 724 - 9\ 2\ 24\ 33,64 \\ \hline \text{Bisextile} \\ 1\text{st January } 724. \end{array}$
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I shall now give Examples to show how to find the Sun's mean Longitude for any particular day or instant, both according to Delalande's Tables, and Table LII.

1^o By Delalande's Tables.

N. B.—In Bisextile years if the proposed date falls in January or February, retrench one day therefrom.

EXAMPLE VI.

Wanted the Sun's mean Longitude for the 11th March A. A. C. 720, at 6^h 49' 10" p. m.

By Example I, ☉'s mean Longitude 1st January A. A. C.	$\begin{array}{r} 9\ 2\ 26\ 23,87 \\ 2\ 8\ 59\ 43,1 \\ 14\ 47,1 \\ 2\ 0,7 \\ 0,4 \\ \hline 11\ 11\ 42\ 55,17 \end{array}$
By Delalande's Table III, ☉'s motion 11th March	
Do. Table IV, for 6 hours	
49 minutes	
10 seconds	
☉'s mean Longitude sought	

Here there would be no difference in the process if, instead of Delalande's, we had used Table LII, because in counting the number of days elapsed from the beginning of the year to the 11th March, we would take 31 days in January, 29 in February, and 11 in March: in all 71 days. But because the proposed year is a Bisextile one, and consequently the Sun's mean Longitude at its beginning, is given for the 1st January at noon, one day is to be retrenched from the sum; the remainder is therefore 70 days, with which referring to the 1st column of the second part of Table LII, we find 2^o 8' 59" 43,1, the same quantity as is given in Delalande's Table for the 11th March.

EXAMPLE VII.

2^o By Table LII.

But if the number of days elapsed are not to be found at once in Table LII, then it must be divided into two parts or more, as the case may require, thus:

Let the Sun's Longitude be required for the 15th March, at 0^h 0' 0" A. D. 1817.—We have in January 31st, in February 28, in March 15, sum 74 days,

By Example IV, ☉'s mean Longitude 31st December 1816	9 21 29 27,5
By Table I. II, part 2, col. 1, for 70 days	2 6 39 42,1
do. do. 4 days	0 3 54 33,7
☉'s mean Longitude sought	0 4 25 43,9

The same result would have been obtained by Delalande's Tables, by the addition of only two quantities:

☉'s mean Longitude 31st December 1816	9 21 29 27,5
By Table III, 15th March	2 12 50 16,4
Same Longitude as before	0 4 25 43,9

There remains only to shew how, by means of the same Tables, the time may be deduced from the Sun's mean Longitude, which is only the converse of the preceding operations, but is to be done by trials when the year is known.

EXAMPLE VIII.

Let the proposed Sun's mean Longitude be $7^{\circ} 5' 38' 42''$ and the year A. D. 542.

By Example II, ☉'s mean Longitude 31st Dec. 541	9 11 36 26,9
By Delalande's Table III	9 23 43 22,4 25th October.
Table IV	17 14,9 7 hours.
Do.	1 38,1 39 minutes.
	2,4 50 seconds.

25th October, $7^{\circ} 39' 59''$, corresponding to 7 5 38 42,0 Longitude.

The same by Table I. II.

The operation by Table I. II is a little longer than by those of Delalande's, owing to the Sun's motion not being registered in it for every day in the year; but it is to be performed by the same process.

☉'s mean Longitude 31st December 541	0 11 36 26,2
Table I. II, part 2, column 1	6 17 7 46,0 200 days.
	2 28 42 29,7 90
	0 7 53 0,0 8
	0 0 17 14,0 7 hours.
	1 38,6 40 minutes Or.
208 days, $7^{\circ} 40' 0''$	7 5 38 42,0

Now by the Supplementary Table, part 2, we have

To the end of September	272 days.
Number of days above found	298
October	23th

The difference of the results by the two sets of Tables is therefore only 1 second of time. It need not be observed, that those who possess Delalande's Tables, will find them the most convenient of the two.

Of the Supplementary Table, Part the First.

Suppose that 298 days have elapsed of the Christian year 542, let it be required to find the Hindu Solar Sydvat date answering to that period which, by the preceding Example, we have found to answer to the 25th October of the said year.

Having determined by the usual process that the Hindu year began on the 19th March, say: from the beginning of the year to the said date there have elapsed 78 days.

But the days expired by proposition are	298
Subtract	78
	220

By the Supplementary Table, part I, to the end of Argeṣi

Remainder	4
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which shews that the 25th October 542, answers to the 4th of the Tamil month *Cartiga*; or of the Bengal one *Margashira*.

INDIAN
CHRONOLOGICAL TABLES,

WITH DIRECTIONS FOR USING THEM.

AN ACCOUNT

Of three Chronological Tables, the contents of which were calculated on the principles disclosed in the Kala Sankalita; exhibiting the numerals, names, characters, and epoch of commencement, or end, according to European account, of 300 Solar and Luni-solar years, concurring with those of the Christian XVIth, XVIIth, and XIXth Centuries; and including eight different Styles, each being used in some part of India.

Also the concurrence of the Christian years with those of the Hijira, and the Epoch of commencement of the latter from A. D. 622 (A. H. 1) to A. D. 1900 (A. H. 1318).



THE doctrines contained in the *Kala Sankalita*, seem at first sight to be such as to interest only those who intend to make a particular study of Indian Astronomy and Chronology; but little adapted to the occasions and taste of that class of readers for which it was originally intended. On a nearer view however, it will be discovered that although a knowledge of the theories which were investigated in that work, may be dispensed with for using the Tables under consideration, yet in our present state of information on the Elements of Hindu Astronomy, on which Indian Chronology must rest, the latter could have given no satisfaction to any class of readers if they had appeared for the first time supported by no sort of authority.

It is moreover to be considered, that the higher questions on Chronology which may be proposed, such as refer to Astronomy, cannot be resolved by any set of Tables only; and that, in such cases, the most ingeniously contrived and most elaborate Tables, require the assistance of theory.

Yet I am prepared to hear it said that in the elementary part of this work, I have exceeded the necessary bounds of an introduction, and that it would have sufficed, since the production of the Chronological Tables was its ultimate

object, to have exhibited the leading features of the systems according to which the Hindus divide time, without entering into those considerations on their manner of operating, which fills so considerable a part of the volume. To which objection I shall answer that had I done so, I would have done nothing; because the difficulty consists principally in our not understanding yet distinctly the mechanism of their computations. For although we have many excellent and profound tracts on the general structure and principles of Hindu Astronomy, yet I do not know of one that would have clearly explained any of the columns of the Tables referred to, although none aspire to any thing higher than the resolution of very simple questions respecting time.

But independently of the above considerations, there is another one, which is of a local nature; and which, if it be true that it applies to our Indian public, must *a fortiori*, act with reduplicated force on all European readers and critics.

There is in every country of Europe a numerous class, which although it cares little for abstract science, yet is well disposed to benefit by its speculations, when aiming at useful results; provided some well qualified person, or body of men, will stand forward, and vouch for the soundness of the principles on which any improvements proposed to its adoption, is grounded: Thus on the signature of some of the members of the Board of Longitude, or of the Academy of the Sciences, the Legislature will adopt, without further examination, a set of new Astronomical Tables, or a new standard measure; and the whole nation will trust to both, without caring if Mendoza valued the accuracy of his Tables more than his life; or how many degrees of the meridian, Delambre and Lambton measured on the surface of the earth.

But in matters of science (and in such matters only), the case stands otherwise in India. If authors are rare among us, critics are still scarcer. Business, in all its various acceptations, is the main spring of the actions of the community. The ministers and officers of a great and powerful sovereign, (as Marquis Wellesley emphatically called the Civil Servants of the Company), the Proconsuls who, under the name of Political Residents, govern the courts of Native Princes; and the Merchants, whose whole attention is fixed on the success of

their own adventures, have too little leisure to attend to the abstract speculations of the unoccupied ; and the military class, like that of every other country, seeks laurels in its appropriate fields.

When, therefore, a production out of the common walks of literature, makes its unexpected appearance, and tries to recommend itself on the score of utility, no one is to be found to imprint that seal upon it, which, like the King's mark on a piece of plate, would cause its practical object to be adopted by the public without a question ; and in such a case there being no one to judge for all, every body expects to be enabled to judge for himself.

The same reasons will induce an European reader to be still less confident ; for at least in India in a case of peremptory necessity, the Native Sastras may be resorted to ; and although they may not be able to convey demonstration according to our own mode of argumentation, many will pronounce with perfect certainty on questions which refer to their theories.

But to what critic in Europe is the reader to address himself, for settling his opinion on a work of this kind ?—If the rudiments of Hindu Chronology are so little known to us, who have (not uneducated) spent the most active part of our lives among the Indians, by what criterion, short of a full exposure of its component parts, will he pass judgment on an insulated instrument, which purports to measure time according to the fancies of nations, some of which he perhaps never heard of in the course of his life ?

It was therefore not only necessary to draw these oriental elements out of the hidden shelves of the Native Astronomers, but to publish them *in toto*, that the Indian Chronological Tables now presented to the public, might be appreciated according to the degree of merit which they may possess. Thus an Indian author who lights the midnight lamp, and gropes unaccompanied, through the obscure and endless windings of Hindu Astronomy, is not only bound to common accuracy, but (if he rightly calculates his chances of success) he must levy, train, and even arm critics, where none were before to be found ; and weapons procured by himself, must lie at all times at the disposal of whoever may feel disposed to turn them against his production.

On the use and application of the Tables.

In giving an account of the Chronological Tables, I shall assume that the reader has not perused a line of the *Kala Sankalita*; and that he is totally ignorant of Hindu Astronomy: but that his object is solely to find, with as little trouble as possible, what Indian or Mahommedan year (of a specified account of time) corresponds to a proposed European year. To determine furthermore the Epoch when the year sought commences or ends; and lastly, to fix the date of commencement of any Hindu *Solar* or Mahommedan month, when that of the beginning of the year is known, with reference to the European Kalendar, and vice versa.

I shall not detain the reader by a tedious description of each column of the three Tables: the best and readiest account that can be given of these is to refer him to the headings of each, which are sufficiently explicit to dispel all fears of confusion.

Supposing therefore, that their respective contents are known, I shall proceed and give examples of each of the above enumerated cases, propounding first any specific Christian year, according either to the old or new styles; and requiring the name, character and beginning of any year registered in the Table.

EXAMPLES.

I.

Let it be proposed to find the years of all the styles referred to in the first Chronological Table which answer to A. D. 1824, N. S.

1st Find the year 1824 in the first column on the left, and keep the eye on the same line.

2^d You will find in column III, that the year of the Cali yug which expires in the month of April is the 4925th; and consequently that the current one after the renewal of the year, is the 4926th.

3^d By column IV, that the year *Saca*, or from the birth of *Saktibahana*, which expires in April, is the 1746th; and that the year which begins then is the 1747th *Saca*.

4th By column V, that the year of the *Æra Parasurama* which ends in the

First Chronological
Table.

The Christian year.

The numeral of that
of the Cali yug.

Do, of Saktibahana.

Of the *Æra* of Para-
surama.

month of September 1824, is the last or 1-1000th year of the 3d Cycle of the same number of years.

5th By column VI, that the Solar year of the *Æra Grahaparterithi*, which ends in April with the common Solar year, is the 48th of the 20th Cycle complete; and that the next year is the 49th of the 21st Cycle current.

Of the *Grahaparterithi*.

6th By column VII, that the *Vrihaspati*, or Jupiter's year which begins ~~for~~ rather which is supposed (to begin) in April 1824, according to the *Surriah Siddhanta* is *Manmatha*, the 29th of the Cycle of 60 years (Hengal).

Name of Jupiter's year according to the *Surriah Siddhanta*.

7th By column VIII, that the same *Vrihaspati* year according to the computation of the *Tellingas* is *Tarana*, the 18th of the Cycle (Peninsula).

Do. according to the *Tellingas*.

For the commencement of all these years.

II.

1st By column IX, we find that the year of the *Cali yug* 4925 ends, and the 4926th begins on Sunday the 11th April 1824, *Civil account*.

Beginning of the Solar year, *Civil* and *Syncretical*.

2nd By column X, that A. C. 4926 began on the 10th of April, at 51 *guddias*, 15 *viguddias*, *Hindu time* (20^h 30^m *European time*) after that of *Sun rising at Lanka*.

3rd The year of *Jupiter* being only used for giving a specific name to the Solar and *Luni-solar* years, their specific duration is not considered in any part of *India*: and on that account their beginnings are not registered in the Table, though these may be ascertained as precisely as any other.

4th The 1000th year of the 3d Cycle of *Parasurama* by column V (2d div.) ends on the 14th September 1824: and the following is the 1st year of the 4th Cycle.

Of the year of *Parasurama*.

NOTE.

Previously to A. D. 1752, the *Julian Calendar* alone was used in *England*. On that account a section of column IX gives the date of beginning of the Solar year, according to the old style, from A. D. 1600, to 1750. The two years that are wanting to reach the Epoch of the reformation, not being of sufficient importance to introduce that column in the Table of the second half of the eighteenth century, have been neglected: but may easily be replaced by the reader, if the occasion should require it.

The same according to the *Julian style*.

The expunged year of Jupiter's Cycle, by the rules of the *Sarrish Siddhanta* corrected by the *Tika*, and that by the *Jyautistava*, do not fall at the same Epoch.

It is also to be observed that during 13 years of a Cycle of 86 years, the *Vrihaspati manva* according to the *Sarrish Siddhanta*, and *Jyautistava*, vary: the latter in present times expunging one year out of the Cycle, 13 years before the former. When that case occurs, the *Charra* year according to both accounts, is inserted opposite to the same Christian year; that by the *Sarrish Siddhanta* being uppermost. It is therefore necessary, when expounding a date by the sole means of the recorded year of Jupiter, to ascertain which style was prevalent in the country where the document was found or executed. This caution, although already given, in another part of this work, cannot be too often repeated for preventing mistakes.

Example.

To give an Example of the two cases under consideration, I shall select A. D. 1660; answering to the 4781st year complete of the *Cali yug*. On referring to the first Chronological Table it appears, that whereas the Civil year 4783 began on Monday the 8th April N. S. (column IX), the same Monday answers to the 28th March O. S. (2d part of the same column),

And whereas the *Vrihaspati* year, which answers to the 4782d year of the *Cali yug*, is *Snela*, (the third of the Cycle) according to the *Sarrish Siddhanta* corrected, it is *Pramoda* (the 4th) by the *Jyautistava* rule.

It is hardly necessary to add, that the letter B annexed to the numeral of any Christian year, or to the date of beginning of a Hindu Solar year, indicates that it is one of 366 days; called *Bisextile* when referred to the former. It is proper however, to state, that the Hindu Leap years so indicated, are derived from the *Sydercal* ones. (Vide 1st Memoir, page 12.)

The Bengalee Solar year called *San*.

The XXth column of the first Chronological Table refers to an account of time totally unknown in the Peninsula of India, but used in the Province of Bengal. It registers the years expired of a style written *San*, but pronounced *Sam*, on the beginning of the common Solar year. The following particulars, which I owe to the favor of Dr. Wilson of the Bengal Service, and which were procured on a reference which I made to him through the kind intervention of my friend Lieutenant Colonel Blacker, (*) constitute all the knowledge I possess on the subject.

(*) Surveyor-General of India.

" The Bengal year or *Sen* (pronounced *Son*) 1232 began this year on the 11th of April, corresponding to their 1st of *Vaisacha*—this is the Solar year. But the Lunar year begins on the day of the new Moon in *Chaitra*, and dates by the same era, being adjusted to the Solar year by the intercalation, when necessary, of a whole month.

" When the Bengal *Sen* was instituted I have not been able to learn, but it is said by some to have been the act of one of the Mahommedan Kings of Bengal; and it seems to bear reference to the *Hejira* year, differing from it at present but 8 years.—It seems likely to have originated in some clumsy attempt to make the Hindus adopt the Mahommedan computation numerically, without adjusting their *Solar* to the *Lunar* year of the *Hejira*. Consequently in about three centuries, it will have lost eight years, or thereabouts, and this corroborates the tradition which assigns its introduction to the Mahommedan Kings of Bengal. We have the same date in use on this side of India, in *Tirhut*, and the Western Provinces.

" The *Vilaity* and *Fussee* years, are at present also 1232: they are both Solar years, but differ in their outset. The *Vilaity* year is reckoned from the first of the *Krishna Padasa*, or Moon's wane in *Chaitra*,—and the *Fussee* on the same in the month of *Askar*. With the difference of a few months, however, they run parallel with the *Sen*, or year of Bengal, and probably originated in a similar mistake."

" In saying that they run parallel, however, I mean merely as to the date of the year through a long series, for the months and days do not always correspond."

From the above account we conclude that the numeral of the *Sen* year, serves to designate both the Solar, and Luni-solar years, in the same manner as the names of those of the Cycle of 60, or *Vrihaspati* years. The way of finding by the Chronological Tables the numeral of the Bengalee year which concurs with any Christian year, is therefore the same in both cases, and requires no particular Example.

N. B.—As the Solar year used in Bengal is that of the *Surriah Siddhanta* ($365^{\circ} 15' 31'' 31'' 24''$), whereas that of the Peninsula is the year according to

the *Aris Siddhanta*, (365⁺ 15⁺ 34⁺ 13⁺), there will occasionally be found the difference of one day between the beginning of the *Saura Mana*, as registered in the first Chronological Table, and that which is current in Bengal; for the reasons stated at pages 63 and 118, in the 1st Appendix p. 239, and pages 62 and 65 of the Tables of the *Kala Sankalita*. Thus whilst the present Solar year 4927 of the *Cali yug* is taken on the Coast to begin on the 11th April; the same year is accounted to commence in Bengal on the 12th April 1825.

It would have been impossible to notice that difference in the General Table, which was principally constructed for the use of the people of the Peninsula.

III.

The second Chronological Table, refers solely to the Luni-solar Astronomical year of the Hindus, called in the Peninsula the *Siddhanta Chandra Mana*. As the construction of that year is very complex, it was not found possible to render the arrangement of the articles registered in its columns, so simple as that of the preceding ones; a proper attention to the following explanations will however, suffice for preventing mistakes.

Column I and II require no explanation.

Column III indicates what is called in this work, the character of the Luni-solar year, which begins during the Christian year registered in a line with it; namely, whether it be a common one of 12 Lunar months; an intercalary one of 13; or lastly, a double intercalary year with an expunged month, being also of 13 Lunar months; two being repeated, and one being left out. (*)

1^o When the space opposite to the year expired of the *Cali yug*, registered in the 2d column, is left blank, it is a sign that the Luni-solar year which is about to commence, is a common *Samvat sara*, and consequently consists of 354 Solar days.

2^o When the letter A is inserted in the said column, it shews that the Luni-solar year which is commencing is an *Adigah samvat sara*, or intercalary year, and therefore that it consists of 384 Solar days. (†)

(*) Vide Key to the *Siddhanta Chandra Mana*, page 71.

(†) For computing what month is to be repeated, see do. page 142.

Second Chronological Table, Luni-solar style.

Indications.

When the approaching Luni-solar year is a common one.

An intercalary one.

3^d And when the letters AC are found in the same column, it indicates that the new year is a *Cahaya sumbat sara*, or double intercalary year with an expunged month. (*)

A double intercalary year with an expunged month.

How these circumstances were determined may be seen in the 3^d part of the Second Memoir, which begins at page 149, the particulars of which are foreign to the object of this article.

It is to be well understood, that in all the cases registered in the second Chronological Table, the intercalation, or suppression of a Lunar month in the approaching Chandra mana, will occur in all the Christian years registered in a line with the character, in the first column; but only in the Luni-solar year which begins on the expiration of that the numeral of which is given in the second; for in present times the renewal of the Hindu Luni-solar year occurs generally in March, or the beginning of April, so that the same Christian year answers in part to two Hindu ones; and the intercalation always occurs in the latter part of the former. (†)

Intercalations,

EXAMPLES.

1st Let the same Christian year 1824, answering to the 4925th and 4926th year of the Cali yug, be proposed.

By Column III, which is left blank, in the same line with 1824, we see that the Luni-solar year 4926 of the Cali yug is a common one, i. e. of 12 Lunar months, or 354 Solar days.

What indicates a common Luni-solar year.

2^d But let A. D. 1801 be proposed, then the letter A opposite to it, in col. III, shews that a Lunar month will be intercalated in the year 4903 of the Cali yug, being the next to 4902 in the 2^d column; and therefore, that the former will consist of 13 Lunar months or 384 Solar days.

An intercalary.

3^d Lastly, let the Christian year be A. D. 1822. As we find the character to be A. C. in the 3^d column, we conclude that two months will be repeated, and

A double intercalary with an expunged month.

(*) For what month is to be expunged, see Key to the Siddhanta Chandra Mana, page 137.

(†) A different arrangement would have confounded all references to the body of the work, in which the Indian system of notation was preserved. The *Ahargunas* given in the IXth and Xth columns would also have no longer tallied with the dates given in the IVth, Vth and VIth, which would have prevented all means of verification.

one expunged in the 4924th year of the Cali yug : so that the Luni-solar year, as in the preceding case, will consist of 13 Lunar months, or 384 Solar days.

How the months to be intercalated, or expunged, are to be determined, is not of the competency of these Tables alone ; but the resolution of these Problems will be found at Article 6, Part II, page 142 of the Key to the Siddhanta Chandra Mana, and other places.

Column IV gives the last feria, or weekly day of the Luni-solar year whose numeral is inserted in the second column.

Column V gives the European date of the last *mean conjunction*, according to *Hindu computation* (derived from the Ahargana inserted in column X), which determines the end of the Luni-solar year registered in the 2d column.

Column VI gives the date of the last conjunction in the year, according to Hindu Solar Sydereal account, and because the Luni-solar year always begins during the last month of the *Solar year*, the dates therein registered, refer invariably to the Solar month *Chitra*, the same as the Tamil *Poongoni*.

This column, independently of the Solar Sydereal, also furnishes the means of finding the *Civil* date of the last day in the Luni-solar year : the difference of which is indicated by a stroke before the figure, implying that the numeral of the *Civil* Solar date, is by one day less than the Sydereal one.

Thus if I want the Solar *Sydereal* and *Civil* date of the last day in the year 4923 of the Cali yug, answering to A. D. 1822, I find in column VI opposite to that Christian year, 13th Chitra, which is the Sydereal date ; but as there is a stroke — before it, I conclude that the *Civil* date is the 12th of the same month. (*)

(*) Vide Key to the Siddhanta Chandra Mana, page 82, for the manner of calculating these dates : but as in the article referred to, the Solar Ahargana which was used, is that by the *Surriah Siddhanta*, whereas that by the Chronological Table is the Ahargana according to the *Aria Siddhanta* (which is preferred by all modern Sastras) the results will differ by one day in the Sydereal, though not so in the Civil account, as may be seen by the following computation, which shews the connection of the columns and of the Tables.

2 ^d . Solar Ahargana, Chron. Table II, col. IX, A. D. 1822	-	1728166	to	12	30
Luni-solar, do. col. X,	-	1728148			
Difference	-	18			

And lastly, by inference, since the Solar *Civil* date of the last conjunction in the year 4923 of the Cali yug fell on the 12th Chitra, it follows that the *Prathama* Tidhi, or first Lunar day of the Luni-solar year 4924, fell on the 13th Chitra of the Solar year 4923, i. e. 19 days before the end of the said year; as was exemplified in the Kalendar exhibited at page 67 of this collection.

This last consideration leads us to another one which may be easily understood, namely, that with reference to the Cycle of Jupiter of 60 years, the Luni-solar will change its name 19 days sooner than the Solar one, the former being called *Vijya* from the 24th March 1822, and the latter still *Nandana* until the 11th April, as may be seen on referring to the first Chronological Table.

In what has been said touching the date of the *Prathama* Tidhi of any year or month, the reader, who is supposed to be unacquainted with the text, must be warned that its being coupled with a particular Solar date, depends on its having begun *before*, or at *Sun* rise; in which case it is coupled with the Solar date with which it mainly coincides.—Or in the latter supposition that it begun *after Sun* rise, for in that case it is registered along with the *ensuing* Solar day. And lastly, that if the said, or any other Tidhi, *begins* and *ends* between two

to be increased by one day, because the Solar counts from *Friday*, and the Luni-solar from *Thursday* = 19 days.

2^d. By Chron. Table I, col. XI, we find for the same year Root = Thursday (4e) 20 12 30 giving Thursday the 11th April, Civil and Sydercal account.

Subtract the constant Root for the month Chitra, Table III

-	(2) 20 21 2
Root 1st Chitra, or Tamul Poongoni	(1) 59 51 23

Monday.

To expound the feria Monday, 1st Chitra, we find by Chronological Table I, column 2, that the Dominical Letter according to the Gregorian Kalendar of the year 1822 is F; with which referring to any Kalendar about the 11th March (about 30 days before the 1st Vaiss'cha shown by the Table to fall on the 11th April) we find that *Monday* the Sydercal date, actually falls on the 11th March; but on account of the 59 guddies in surplus (exceeding 206) on the 12th Civil account.

From this computation it is manifest that the Sydercal Solar month Chitra counts 31 days and the Civil only 30, (because the fractional Root for Vaiss'cha was only 20 gud.) Hence if from 1st Vaiss'cha, or 32 days from the 1st Chitra, we retrench 19, there remains 13 for the Sydercal date sought, and for the same reason the Civil date will be 12th Chitra.

Sun-risings on the same Solar day, it is entirely left out of the Luni-solar Kalendar. (*)

Thus the VIth column of the second Chronological Table expounds three cases by mere inspection, which cannot be resolved by the common rules without very considerable labour. It is almost needless to add, that when the true time of Sun rising is referred to, as it occurs in any Latitude or Longitude arbitrarily proposed, the precise Solar date of the *Anantya*, and *Prathama Tithis*, above considered, may vary from what it is computed for *Lanea* in the Chronological Table. But as this difference can only occur when the last conjunction falls very near the time of Sun rising, the case is a rare one, and at all events cannot affect the Tabular results, more than one day one way or the other.

The VIIth, VIIIth, IXth and Xth columns of the 2d Chronological Table, can only be of use to those who, having learnt the methods disclosed in the *Kala Sankalita*, might wish to compute the minuter circumstances of the Luni-solar year, with a view to fix an Epoch with great precision. They are introduced to save the computer a vast deal of trouble, and occasions of mistakes, in furnishing him at once with two of the Elements on which all Luni-solar computations depend; and also for giving to the uninformed an opportunity of tracing the connection between the Solar and Luni-solar divisions of time.

Column XI registers the year expired from the origin of the æra of *Vicramaditya*, a style which is used to number the Luni-solar years from an Epoch more recent than the beginning of the *Cali yug*; in the same manner as the æra of *Salivahana* is applied to the Solar years.

Thus if the numeral of the Luni-solar year which ends in A. D. 1824 be required according to the style of *Vicramaditya*, we find by the column referred to, that it is the 1181st, ending on the 30th March of the said Christian year.

IV.

The third Chronological Table, which is general for all years of the *Hejira* from A. D. 622 to 1900, is so constructed, that when you have found the

Third Chronological Table, yrs of the Hejira Luni-solar years.

(*) Vide Key to the *Siddhanta Chandra Mansa*, page 72.

numeral of the Mahomedan year which corresponds to the proposed Christian one, you know (what is called) the *Character* of the year; by which is meant the *seria* or weekly day on which it begins; and this *Root*, or *Character*, serves to find the commencement of every month in the Lunar year: for the years of the Hejira are arranged in the respective columns according to the day of the week on which each begins. This arrangement though in some respects less convenient than when the common series is followed, has in others, the advantage of avoiding errors when taking the numerals and other indices of the circumstances of the Lunar year out of the Table; and affords great facilities for comparing the Initial Roots and *Soota dina* of the Indian and Mahomedan years.

The era of the Hejira is divided into cycles of 30 years, at the end of which, the intercalation of the months, which occur in the 2d, 5th, 7th, 10th, 13th, 16th, 18th, 21st, 24th, 26th and 29th resume the same series. In intercalary years, one day is to be added to the last Lunar month, called *Zoolledgee*; making that month consist of 30 days instead of 29, which is its duration in common years. These are indicated by the letter B, and the years ending the cycle of 30 years by a stroke = and asterisk * above and below the same year.

EXAMPLE.

Let it be required to find the numeral, and date of the commencement of the year of the Hejira which answers to A. D. 1824. Example.

Referring to that part of the General Table which contains the years of the XIXth century, I find A. H. 1240 in the column under *Thursday*; its Root is therefore 5; it appears also that its beginning falls on the 14th O. S. and 26th August N. S. and as it is marked with an asterisk, that it is an *intercalary* one, i. e. of 355 Solar days; its month *Zoolledge* counting 30 days. This process is so simple, that it requires no further exemplification.

To find by means of the first Chronological Table the European date of beginning of each Solar month of the Hindu Sydereal years.

V.

For this purpose I shall give here an abridgment of Table III of the present collection, which will suffice for resolving all common cases.

How to ascertain the beginning of the Hindu Solar months.

The Root of days to be counted from Sunday.

	Hindu names of Solar months.	Tamul names of months.	Root of duration of every Solar month.	Collective Roots of months according to their standing to the year.	European months commencing N. S.
γ	Vaisācha	Chaitram	D. S. T. P. (2) 55 32 1	D. S. T. P. (2) 55 32 1	April
δ	Jyāishṭā	Vyāṣai	(3) 21 12 1	(6) 19 41 2	May
η	Āshar	Auni	(3) 56 33 1	(2) 56 22 3	June
≡	Śrāvana	Audi	(3) 23 12 2	(6) 24 34 5	July
Ω	Bhādra	Aurani	(3) 2 10 1	(2) 26 44 6	August
∞	Aśvina	Parvati	(2) 27 23 1	(4) 34 6 7	September
⊃	Cartiga	Arpaci	(1) 54 7 1	(6) 43 13 8	October
∩	Mārgaśīra	Cartiga	(1) 35 24 2	(1) 13 37 10	November
⊄	Pauṣia	Margall	(1) 20 53 1	(2) 39 30 11	December
∨	Māgha	Tya	(1) 27 16 1	(4) 6 45 12	January
=	Phal'guna	Maasi	(1) 48 24 1	(5) 53 10 13	February
⋈	Chaitra	Ponguni	(2) 20 21 2	(1) 15 31 15	March

EXAMPLE I.

Example.

Let it be proposed to find the European date of commencement of the Solar month *Jyāishṭā* (Tamul *Vyāṣai*) of the 4926th year of the Cali yug, answering to A. D. 1824.

1: Referring to the first Chronological Table we find opposite to 1824 the Initial Root of the Solar year, - - - 10th April (6th) 51: 15: 0th

To which add that for the month *Vaisācha* in the above Table (2) 55 32 1 1

Initial Root 1st of *Jyāishṭā* - - - (2) 46 47 1

Tuesday, SYDEREAL: Wednesday, CIVIL (*).

2: To expound the monthly dates of these series, we find in the second column opposite to 1824 (1st Chronological Table) that the Dominical Letters for that year, according to the new style, are DC. Referring therefore to any Kalendar with the Letter C, about 30 days after the 10th April, we find that the Tuesday above found, falls on the 11th, and Wednesday on the 12th May, which are the Sydereal and Civil dates of beginning of the Solar month *Vaisācha* sought.

(*) The Civil account takes one day more when the fraction of the Root in guddias exceed 30.

EXAMPLE II.

Let the commencement of the Solar month *Māgha* (Tamul Tye) be required.

	D.	C.	V.	P.
The Initial Root for A. C. 4926 remaining as before	-	(6)	51	15 0
Take out of the small Table the Collective Root up to				
<i>Paushia</i> , which add	-	(2)	39	30 11
Initial Root 1st of <i>Māgha</i>	-	(2)	30	45 11

Tuesday, SYDEREAL: *Wednesday*, CIVIL.

Here as the Solar month *Māgha*, falls in *January* of the year 1825, we refer again to the first Chronological Table for the Dominical Letter of that year, which we find to be B, and as the beginning of the eleven last months of the year cannot fall wider in each month from the date of the 1st *Vaisācha* in April than 4 days, (*) referring to the Kalendar in January 1825, we find the *Tuesday* above found to fall on the 11th January; and *Wednesday* on the 12th, being the *Sydercal* and *Civil* date of the 1st *Māgha* (Tamul Tye) sought.

The above method is so plain, that it would be useless to multiply examples any further.

VI.

As for determining the beginning of the Lunar months of the *Siddhanta Chandra Mana* by means of Tables only, it was abundantly shewn in the text that such an attempt would be vain; because the *Tidhis* of which these months are composed, depend on no absolute progress of the Sun or Moon in their orbits; but on their apparent relative motion; and because the manner of registering them in the Kalendar is determined by circumstances which have never been attended to by any other known people. (†)

Supposing however, that the reduction of any number of *Tidhis* into a corresponding one of Solar days, could be effected with precision by a mechanical process, this would be of little advantage in practice; for the Luni-solar style has long since been banished from all civil concerns, and was only retained for the superstitious observances and practices of the Hindus.

The beginning of the Lunar months of the *Chandra Mana* not susceptible of being ascertained by the Tables.

(*) Vide Key to the *Madhyaṃa Saura Mana*, page 15.

(†) Vide Key to the *Siddhanta Chandra Mana*, page 72.

Approximation of
the same.

If nevertheless, an approximation of the European date of the *Prathama* Tidhi of any of the Lunar months of the year were absolutely wanted, it may be obtained by the following easy process.

As whatever be the real duration of the Lunar Synodical month, it is always divided into 30 Tidhis, the last of which is that of the *Amavasya* or conjunction, and as the common Lunar Civil year is of 354 *Baumi* *Saras*, or natural days (more nearly $354^{\circ} 22' 1'' 12''$), we have the following proportion.

As 360 Tidhis, to 354 Solar days, so 30 Tidhis, to $29\frac{1}{2}$ Solar days.—Hence if to the date of last mean conjunction in the preceding year, given in the 5th column of the second Chronological Table, we add as many times 29 days 30 guddias, as the proposed month is removed of units from the first month in the year, we shall have nearly the Civil date of its end.

EXAMPLE:

Example.

Thus let the same year of the Caliyug 4926 (A. D. 1824) be again proposed, finding by column V. 2d Chronological Table, that the last *Amavasya* of 4925 fell on Tuesday the 30th March, if to this date we add $29^{\circ} 30'$, the last *Amavasya* of the Lunar month *Chitra* will fall nearly on the 29th of April; and the *Prathama* Tidhi of *Vaisācha* on the 30th. For the last *Amavasya* in *Vaisācha*, it will be $2 \times 29^{\circ} 30' = 59$ days, which added as before to the 30th March will fall on the 28th May, and the *Prathama* Tidhi of the Lunar month *Jyāishṭhā* will be the 29th nearly. And lastly, for the end of the Lunar month *Māgha*, the 11th of the *Chandra* *Mana*, we have $11 \times 29^{\circ} 30' = 324^{\circ} 30'$, which added to the 30th March 1824, will give the 17th February 1825, the *Prathama* Tidhi of *Phalgunā*, the 12th Lunar month falling very nearly on the 18th February.

If the year which is proposed, be marked with an A, or AC in the third column of the Chronological Table, which indicates a year of 13 Lunar months, or 384 days, (more nearly $383^{\circ} 55' 57'' 48''$) then the arrangement of the months in the new *Chandra* *Mana*, will be disturbed by the intercalation; and as the Table does not inform us which is the intercalated month, the above process will only indicate the numerals, and not the names of the successive months; but it will still approximate the date of their endings: for $13 \times 29^{\circ} 30' = 383^{\circ} 30'$, very near the true duration of the intercalated Luni-solar year.

For the European date of the commencement of the Mahommedan Lunar months.

There remains now only to shew how the beginnings of the months of the Lunar year of the Mahommedans may be computed by help of the third General Table, for which we have the following subsidiary one:

How to expound
the beginning of
the Mahommedan
months.

The Civil months, as has already been said, are alternately of 30 and 29 days, excepting the last, which in common years is of 29, and in intercalary ones, of 30 days.

The figures in a line with *Mahorum*, indicate the 7 series by which the Mahommedan year may begin, 1 answering to Sunday,

2 to Monday, and so forth to 7 which answers to Saturday.

The figures which follow underneath in the same perpendicular line, shew the initial series of all the other months in the same year. With regard to the Dominical Letter which is necessary for expounding the European date, it may be either deduced from Table III, or found at once in Table II. As for the application of these data, it will best be shewn by an

EXAMPLE.

Let the same year 1824 be proposed, which as we have found at page xv, answers to the 1240th of the Hejira, the Root of which is 5; and whose beginning falls on the 26th August N. S.

Referring to the subsidiary Table, we refer to the column at the top of which 5 is registered, then following it downwards, we find 7, or Saturday, the initial series of *Sepher*; then counting 30 days from the 26th August, we find that the said month begins on the 25th September.

Example.

Number of days in each month	Names of Arabic months.	Initial series of months.						
29	Mahorum - -	1	2	3	4	5	6	7
29	Sepher - - -	3	4	5	6	7	1	2
30	Rabi-el-Awel -	4	5	6	7	1	2	3
29	Rabi-el-Akher -	6	7	1	2	3	4	5
29	Ghumadi-el-Awel -	7	1	2	3	4	5	6
29	Ghumadi-el-Akher	5	6	7	1	2	3	4
30	Regeb - - -	3	4	5	6	7	1	2
29	Shamaban - -	5	6	7	1	2	3	4
30	Rhamadan - -	5	7	1	2	3	4	5
29	Shawal - - -	1	2	3	4	5	6	7
30	Zoolcada - -	2	3	4	5	6	7	1
29 or 30	Zoolidgee - -	4	5	6	7	1	2	3

For Rabi-el-Avul, the next Root is I, or Sunday; then counting 29^d from the 25th September, we find that the said month begins on the 24th of October; and so forth, down to the 12th month Zoolledgee.

For this last month, as we find a B annexed to the 1240th year of the Hejira in the third Chronological Table, we conclude that it is an intercalary one; therefore, after having determined by the preceding process that Zoolledgee began on Sunday the 17th July (the Dominical Letter being now B), instead of counting 29 days from that date, we are to take 30, which adding to the 17th July, falls on Tuesday the 16th of August, the initial seria and date of beginning of the 1241st year of the Hejira; as may be seen on referring to the General Table.

The converse of all the preceding methods, is too obvious to need any particular Example; because all that is required is, to refer to the Chronological Tables with the Indian or Mahommedan year proposed. The European year concurring therewith being registered on the same line in its appropriate column, the question is at once reduced to some of those which were proposed in the preceding cases, and therefore needs no further explanation.



FIRST CHRONOLOGICAL TABLE, referring to various Indian Solar styles and years; and showing the numerals or names, and the Epoch of the commencement of the latter according to European accounts.

L.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.	X.	XI.	XII.								
Christian years.	Dominical Letter O. S.	Dominical Letter N. S.	Years expired of the Q. S. year.	Years expired from the birth of Subrahma.	Years of the Cycle of 60 years or Friday-patti, Bengal reckoning.	Years of the Cycle of 60 years or Friday-patti, Bengal reckoning.	Years of the Cycle of 60 years as reckoned South of the River Neran-da.	Initial term of Tumul (N. S.)	Date in April N. S.	Date in March O. S.	Initial term of Tumul (N. S.)	Date in April N. S.	Years of beginnings of Tumul years counted from Sunday.	Receptive year called					
1600	FE	BA	4701	1525	775	10	4	Saunhya	43	Sarvazi	34	Fri	7	27	Th	6	B (4) 34 35 0	1000	
1	D	G	2	3	7	11	5	Sādharama	44	Flava	35	28	Sat	7	28	Sat	7	(0) 10 0 15	7
2	C	F	3	4	8	12	6	Virōdhari	45	Sādhari	36	29	Sun	7	29	Sun	7	(0) 25 37 30	8
3	B	E	4	5	9	13	7	Prōdhāri	46	Sādhara	37	30	Mo	7	30	Mo	7	(1) 41 8 45	9
4	AG	DC	5	6	10	14	8	Prāmādi	47	Crādhi	38	31	Tu	7	31	Tu	7	B (3) 56 40 0	1010
5	F	B	6	7	11	15	9	A'moda	48	Viwāratā	39	32	We	7	32	We	7	(4) 12 11 25	1
6	E	A	7	8	12	16	10	Rac'shana	49	Pa'dhāra	40	33	Fri	7	33	Fri	7	(5) 27 42 30	2
7	D	G	8	9	13	17	11	Anala	50	Flavanga	41	34	Sat	7	34	Sat	7	(6) 43 13 45	3
8	CB	FE	9	10	14	18	12	Pingala	51	Gilara	42	35	Sun	7	35	Sun	7	B (0) 58 45 0	4
9	A	D	10	11	15	19	13	Cālayunta	52	Saunhya	43	36	Mo	7	36	Mo	7	(2) 14 16 15	5
1610	G	C	11	12	16	20	14	Sidh'anti	53	Sādhama	44	37	We	7	37	We	7	(3) 29 47 30	6
1	F	B	12	13	17	21	15	Raudra	54	Virōdhari	45	38	Fri	7	38	Fri	7	B (4) 45 10 45	7
2	ED	AG	13	14	18	22	16	Durmādi	55	Prōdhāri	46	39	Sat	7	39	Sat	7	(6) 0 50 0	8
3	C	F	14	15	19	23	17	Dundubhi	56	Prāmādi	47	40	Sun	7	40	Sun	7	(0) 16 21 15	9
4	B	E	15	16	20	24	18	Rudrādgari	57	A'moda	48	41	Tu	7	41	Tu	7	(1) 31 52 30	1020
5	A	D	16	17	21	25	19	Ractesha	58	Rac'shana	49	42	We	7	42	We	7	B (2) 47 23 45	1
6	GF	CB	17	18	22	26	20	Crōdhana	59	Anala	50	43	Th	7	43	Th	7	(4) 2 55 0	2
7	E	A	18	19	23	27	21	Esha	60	Pingala	51	44	Fri	7	44	Fri	7	(5) 18 10 15	3
8	D	G	19	20	24	28	22	Prabhava	1	Cālayunta	52	45	Sun	7	45	Sun	7	(6) 33 57 30	4
9	C	F	20	21	25	29	23	Vibhava	2	Sidh'anti	53	46	Mo	7	46	Mo	7	B (0) 49 23 45	5
1620	BA	ED	21	22	26	30	24	Sula	3	Raudra	54	47	We	7	47	We	7	(2) 5 0 0	6
1	G	C	22	23	27	31	25	Prāmādi	4	Durmādi	55	48	Fri	7	48	Fri	7	(3) 20 31 15	7
2	F	B	23	24	28	32	26	Prājāpati	5	Dundubhi	56	49	Sat	7	49	Sat	7	(4) 36 2 30	8
3	E	A	24	25	29	33	27	Angira	6	Rudrādgari	57	50	Th	7	50	Th	7	B (5) 51 33 45	9
4	DC	GF	25	26	30	34	28	Srimoc'ha	7	Ractesha	58	51	Sun	7	51	Sun	7	(0) 7 5 0	1020
5	B	E	26	27	31	35	29	Bhāva	8	Crōdhana	59	52	Mo	7	52	Mo	7	(1) 22 36 15	1
6	A	D	27	28	32	36	30	Yurā	9	Esha	60	53	We	7	53	We	7	(2) 38 7 30	2
7	G	C	28	29	33	37	31	Dhātā	10	Prabhava	1	54	Th	7	54	Th	7	B (3) 43 38 45	3
8	FE	BA	29	30	34	38	32	Iswara	11	Vibhava	2	55	We	7	55	We	7	(5) 9 10 0	4
9	D	G	30	31	35	39	33	Schudanya	12	Sula	3	56	Sat	7	56	Sat	7	(6) 24 41 15	5
1630	C	F	31	32	36	40	34	Prāmādi	13	Prāmādi	4	57	Mo	7	57	Mo	7	(0) 40 12 30	6
1	B	E	32	33	37	41	35	Vicrama	14	Prājāpati	5	58	Tu	7	58	Tu	7	B (1) 55 43 45	7
2	AG	DC	33	34	38	42	36	Brīja	15	Angira	6	59	We	7	59	We	7	(3) 11 13 0	8
3	F	B	34	35	39	43	37	Chitrab'ha	16	Srimoc'ha	7	60	Th	7	60	Th	7	(4) 26 46 15	9
4	E	A	35	36	40	44	38	Sādhara	17	Bhāva	8	1	Sat	7	1	Sat	7	(5) 42 17 30	1040
5	D	G	36	37	41	45	39	Tārana	18	Yurā	9	2	Sun	7	2	Sun	7	B (0) 57 48 45	1
6	CB	FE	37	38	42	46	40	Pārthiva	19	Dhātā	10	3	Mo	7	3	Mo	7	(1) 13 20 0	2
7	A	D	38	39	43	47	41	Vyāsa	20	Iswara	11	4	Th	7	4	Th	7	(2) 28 51 15	3
8	G	C	39	40	44	48	42	Sarvajit	21	Bahulanya	12	5	We	7	5	We	7	(3) 44 22 30	4
9	F	B	40	41	45	49	43	Sarvadhāri	22	Prāmādi	13	6	Fri	7	6	Fri	7	B (4) 59 33 45	5
1640	ED	AG	41	42	46	50	44	Virōdhi	23	Vicrama	14	7	Sat	7	7	Sat	7	(0) 15 25 0	6
1	C	F	42	43	47	51	45	Vicrta	24	Brīja	15	8	Sun	7	8	Sun	7	(3) 20 16 15	7
2	B	E	43	44	48	52	46	Chara	25	Chitrab'ha	16	9	Mo	7	9	Mo	7	B (1) 46 27 30	8
3	A	D	44	45	49	53	47	Nandana	26	Sādhara	17	10	We	7	10	We	7	(4) 1 38 45	9
4	GF	CB	45	46	50	54	48	Vijya	27	Tārana	18	11	Th	7	11	Th	7	(6) 17 30 0	1050
5	E	A	46	47	51	55	49	Jya	28	Pārthiva	19	12	Fri	7	12	Fri	7	(5) 53 1 15	1
6	D	G	47	48	52	56	50	Manmat'ha	29	Vyāsa	20	13	Sat	7	13	Sat	7	B (6) 48 32 30	2
7	C	F	48	49	53	57	51	Durmoc'ha	30	Sarvajit	21	14	Mo	7	14	Mo	7	(1) 4 3 45	3
8	BA	ED	49	50	54	58	52	Homalamra	31	Sarvadhāri	22	15	Tu	7	15	Tu	7	(2) 19 35 0	4
9	G	C	50	51	55	59	53	Vilasa	32	Virōdhi	23	16	We	7	16	We	7	(3) 35 6 15	5
1650	F	B	51	52	56	60	54	Vicrta	33	Vicrta	24	17	Th	7	17	Th	7	B (4) 50 57 30	6

I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.	X.	XI.	XII.
Christian year.	Dominical Letter O. S.	Dominical Letter N. S.	Years expired of the Cal. yug.	Years expired from the birth of Salsabana.	Years of the Cycle of the Aka Parasurama.	Years of the Cycle of 60 years of Vikingsatt, Bengali reckoning.	Years of the Cycle of 60 years as reckoned South of the River Nerunda.	Initial term of Tattatived at about N. S.	Days to March O. S.	Initial term of Tattatived at about N. S.	Days to April N. S.
						Current year.	Current year.				
1651	E	A	4752	1573	827	12	53	Sarrari	34	Chera	25
B 2	DC	GF	3	4	8	11	56	Piana	35	Nandana	26
3	B	E	4	5	9	11	57	Sabbacrit	28	Vijya	27
4	A	D	5	6	10	11	58	Sabbhana	37	Jya	28
5	G	C	6	7	11	12	59	Crādhi	34	Manmat'ha	29
B 6	FE	BA	7	8	12	11	60	Viswāvasā	30	Darmach'ha	30
7	D	G	8	9	1	11	61	Parābhava	40	Hemalāsa	31
8	C	F	9	10	2	11	62	Piranga	41	Vilāsa	32
9	B	E	10	11	3	12	63	Cilāra	42	Vigari	33
1060	AG	DC	1	2	4	11	64	Saunya	43	Sarara	34
1	F	A	2	3	5	11	65	Sādhāra	44	Plava	35
2	E	A	3	4	6	11	66	Virōdhacrit	45	Sabbacrit	36
3	D	G	4	5	7	12	67	Paridhāvi	46	Sādhāra	37
B 4	CB	FE	5	6	8	11	68	Pramādi	47	Crādhi	38
5	A	D	6	7	9	11	69	A'nanda	48	Viswāvasā	39
6	G	C	7	8	10	11	70	Rac'hasa	49	Parābhava	40
7	F	B	8	9	11	12	71	Anala	50	Piranga	41
B 8	ED	AG	9	10	12	11	72	Pingala	51	Citica	42
9	C	F	10	11	1	12	73	Cālayucta	52	Saunya	43
1070	B	E	1	2	2	11	74	Siddhārti	53	Sādhāra	44
1	A	D	2	3	3	12	75	Raudra	54	Virōdhacrit	45
B 2	GF	CB	3	4	4	11	76	(Darmat'ha) 55	Paridhāvi	46	Fri 8 28
3	E	A	4	5	5	11	77	Darm. Dand 56	Pramādi	47	Sat 3 28
4	D	G	5	6	6	11	78	Rudrōdgarī 57	A'nanda	48	Sun 8 29
5	C	F	6	7	7	12	79	Ractāccha 58	Rac'hasa	49	Mo 9 29
B 6	BA	ED	7	8	8	11	80	Crādhi 59	Anala	50	We 8 28
7	G	C	8	9	9	11	81	Cālayucta 60	Pingala	51	Th 8 28
8	F	B	9	10	10	12	82	Siddhārti 61	Cālayucta	52	Fri 8 28
9	E	A	10	11	11	12	83	Raudra 62	Siddhārti	53	Sat 8 28
1080	DC	GF	1	2	12	11	84	(Darmat'ha) 63	Ractāccha	54	Mo 8 28
1	B	E	2	3	1	12	85	Pramādi 64	Darmat'ha	55	Fri 8 28
2	A	D	3	4	2	12	86	Rudrōdgarī 65	Dundobhi	56	We 8 28
3	G	C	4	5	3	12	87	Ractāccha 66	Rudrōdgarī	57	Th 8 28
B 4	FE	BA	5	6	4	11	88	Cālayucta 67	Ractāccha	58	Sat 3 28
5	D	G	6	7	5	11	89	Siddhārti 68	Crādhi	59	Sun 8 28
6	C	F	7	8	6	12	90	Raudra 69	Cālayucta	60	Mo 9 29
7	B	E	8	9	7	12	91	Pramādi 70	Pramādi	1	Th 8 28
B 8	AG	DC	9	10	8	11	92	Ractāccha 71	Siddhārti	2	Fri 8 28
9	F	A	10	11	9	12	93	Cālayucta 72	Ractāccha	3	Th 8 28
1090	E	A	1	2	10	12	94	Pramādi 73	Pramādi	4	Sat 3 28
1	D	G	2	3	11	12	95	Rudrōdgarī 74	Ractāccha	5	Sun 8 28
B 2	CB	FE	3	4	12	11	96	Cālayucta 75	Cālayucta	6	Mo 9 29
3	A	D	4	5	1	12	97	Siddhārti 76	Pramādi	7	Th 8 28
4	G	C	5	6	2	12	98	Ractāccha 77	Ractāccha	8	Fri 8 28
5	F	B	6	7	3	12	99	Cālayucta 78	Cālayucta	9	Sat 3 28
B 6	ED	AG	7	8	4	11	100	Pramādi 79	Pramādi	10	Sun 8 28
7	C	F	8	9	5	11	101	Rudrōdgarī 80	Rudrōdgarī	11	Mo 9 29
8	B	E	9	10	6	12	102	Ractāccha 81	Ractāccha	12	Th 8 28
9	A	D	10	11	7	12	103	Cālayucta 82	Cālayucta	13	Fri 8 28
1700	GF	CB	1	2	8	12	104	Siddhārti 83	Siddhārti	14	Sat 3 28

(*) The upper numbers, printed in italics, are those by the Sarrari Sindhana; the lower ones, printed in roman, are those by the Jyotishana.

L.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.	X.	XI.	XII.		
Christian years.	Doulish Letter O. S.	Doulish Letter S. S.	Years elapsed of the that year.	Years elapsed from the birth of Sathya Sai.	Years of the Cycle, recounting from the beginning of the Cycle.	Years of the Cycle of 60 years or Pratyak, 1000 recounting.	Years of the Cycle of 60 years as reckoned South of the River Narmada.	Initial letter of the year.	Initial letter of the year.	Initial letter of the year.	Initial letter of the year.		
1701	E	B	1802	152	377	12	15	Chara	25	Belaya	13	(6) 2 11 15	1107
2	D	A	3	4	378	13	16	Nandana	26	Chakra	14	(0) 17 42 30	8
3	C	G	4	5	379	14	17	Vijaya	27	Sadhana	15	(1) 33 13 45	9
B 4	BA	FE	5	6	380	15	18	Jya	28	Taruna	16	B (2) 48 48 0	1110
5	G	D	6	7	381	16	19	Mahamat'ha	29	Parthiva	17	(4) 4 16 15	3
6	F	C	7	8	382	17	20	Darmach'ha	30	Vyaya	18	(5) 19 47 30	2
7	E	B	8	9	383	18	21	Hemalaya	31	Sarvjit	19	(6) 35 18 45	3
B 8	DC	AG	9	10	384	19	22	Vilaya	32	Sarvadhari	20	B (0) 50 50 0	4
9	D	A	10	11	385	20	23	Vicari	33	Virodhi	21	(2) 6 21 15	5
1710	A	E	1	12	386	21	24	Sarvati	34	Vicari	22	(3) 21 32 30	6
1	G	D	2	13	387	22	25	Phara	35	Chara	23	(4) 37 23 45	7
B 2	FE	CB	3	14	388	23	26	Sadhacrit	36	Nandana	24	B (5) 52 55 0	8
3	D	A	4	15	389	24	27	Sadhana	37	Vijaya	25	(0) 8 26 15	9
4	C	G	5	16	390	25	28	Criddhi	38	Jya	26	(1) 23 57 30	1120
5	B	F	6	17	391	26	29	Vikramad	39	Mahamat'ha	27	(2) 39 23 45	1
B 6	AG	ED	7	18	392	27	30	Paradhara	40	Darmach'ha	28	B (3) 55 0 0	2
7	F	C	8	19	393	28	31	Pharanga	41	Hemalaya	29	(5) 10 31 15	3
8	E	B	9	20	394	29	32	Giloca	42	Vilaya	30	(6) 26 2 30	4
B 9	D	A	10	21	395	30	33	Saunhya	43	Vicari	31	(0) 41 33 45	5
1720	CB	GF	1	22	396	31	34	Sadhana	44	Sarvati	32	B (1) 67 5 0	6
1	A	E	2	23	397	32	35	Virodhacrit	45	Phara	33	(3) 12 33 15	7
2	G	D	3	24	398	33	36	Paridhara	46	Sadhacrit	34	(4) 28 7 30	8
3	E	C	4	25	399	34	37	Pramadi	47	Sadhana	35	(5) 43 38 45	9
B 4	ED	BA	5	26	400	35	38	A'panda	48	Criddhi	36	B (6) 59 10 0	1130
5	C	G	6	27	401	36	39	Rac'shana	49	Vikramad	37	(1) 14 41 15	1
6	B	F	7	28	402	37	40	Anala	50	Paradhara	38	(2) 30 12 30	2
7	A	E	8	29	403	38	41	Pharanga	51	Pharanga	39	B (3) 45 43 45	3
B 8	GE	DC	9	30	404	39	42	Giloca	52	Giloca	40	(5) 1 15 0	4
9	E	B	10	31	405	40	43	Saunhya	53	Saunhya	41	(6) 16 46 15	5
1730	D	A	1	32	406	41	44	Sadhana	54	Sadhana	42	(0) 32 17 30	6
1	G	D	2	33	407	42	45	Darmati	55	Virodhacrit	43	B (1) 47 48 45	7
B 2	BA	FE	3	34	408	43	46	Dundubhi	56	Paridhara	44	(3) 3 20 0	8
3	C	G	4	35	409	44	47	Rudirodgar	57	Pramadi	45	(4) 18 57 15	9
4	F	C	5	36	410	45	48	Rac'shana	58	A'panda	46	(5) 34 22 30	1140
5	E	B	6	37	411	46	49	Criddhi	59	Rac'shana	47	B (0) 49 53 45	1
B 6	DC	AG	7	38	412	47	50	Cakra	60	Anala	48	(1) 5 25 0	2
7	B	F	8	39	413	48	51	Pradhara (*)	1	Pharanga	49	(2) 20 56 15	3
8	A	E	9	40	414	49	52	Vibhava	2	Giloca	50	(3) 36 27 30	4
B 9	G	D	10	41	415	50	53	Sula	3	Sadhacrit	51	B (4) 51 58 45	5
1740	FE	CB	1	42	416	51	54	Pramoda	4	Rac'shana	52	(6) 7 50 0	6
1	D	A	2	43	417	52	55	Penjapati	5	Darmati	53	(0) 23 1 15	7
2	C	G	3	44	418	53	56	Angira	6	Dundubhi	54	(1) 38 32 30	8
3	B	F	4	45	419	54	57	Srinus'ha	7	Rudirodgar	55	B (2) 54 2 45	9
B 4	AG	ED	5	46	420	55	58	Blav'ri	8	Rac'shana	56	(4) 9 35 0	1150
5	F	C	6	47	421	56	59	Yoda	9	Criddhi	57	(5) 26 6 15	1
6	E	B	7	48	422	57	60	Dhiti	10	Cakra	58	(6) 40 37 30	2
7	D	A	8	49	423	58	61	Iswara	11	Pradhara (*)	59	B (0) 56 8 45	3
B 8	CB	GF	9	50	424	59	62	Babodanya	12	Vibhava	60	(1) 11 40 0	4
9	A	E	10	51	425	60	63	Pramati	13	Sula	1	(3) 27 11 15	5
1750	G	D	1	52	426	61	64	Vicrama	14	Pramoda	2	(4) 42 42 30	6

(*) Beginning of the 834 Cycle of Jupiter, Suriah Siddhanta.

(*) Beginning of the 834 Cycle, Tellinga account.

I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.	X.	XI.	XII.
Christian year.	Dominical Letter O. S.	Dominical Letter N. S.	Years expired in the Cycle.	Years expired from the birth of Suddhanta.	Years of the Cycle of the 28th Manu.	Years of the Cycle of 60 years as reckoned by the Hindus.	Years of the Cycle of 60 years as reckoned by the River-Sarmas.	Years of the Cycle of 60 years as reckoned by the River-Sarmas.	Years of the Cycle of 60 years as reckoned by the River-Sarmas.	Years of the Cycle of 60 years as reckoned by the River-Sarmas.	Years of the Cycle of 60 years as reckoned by the River-Sarmas.
1751	P	C	1802	1073	027	11	05	Bhaya	13	Prajapati	5
B	ED	BA	4	4	3	13	06	Gaurahana	10	Angura	6
2	C	G	5	5	4	13	07	Siddhanta	17	Sarmas	7
3	B	F	6	6	5	13	08	Pāra	18	Bhaya	8
4	A	E	7	7	6	13	09	Pārthiva	19	Yara	9
B	GF	DC	8	8	7	13	10	Vyaya	20	Rata	10
7	E	B	9	9	8	13	11	Sarmas	21	Angura	11
8	D	A	10	10	9	13	12	Sarmas	22	Babundanya	12
9	C	G	1800	1	10	13	13	Vicra	23	Pramāthi	13
1750	BA	FE	1	2	11	13	14	Vicra	24	Vicra	14
1	G	D	2	3	12	13	15	Nandana	25	Bhaya	15
2	F	C	3	4	13	13	16	Chandhana	26	Chandhana	16
3	E	B	4	5	14	13	17	Siddhanta	27	Sun	17
B	DC	AG	5	6	15	13	18	Taruna	28	Mo	18
5	B	F	6	7	16	13	19	Farthava	29	We	19
6	A	E	7	8	17	13	20	Vyaya	30	Th	20
7	G	D	8	9	18	13	21	Sarmas	31	Fri	21
B	FE	CB	9	10	19	13	22	Sarmas	32	Sat	22
9	D	A	4870	1	20	13	23	Vicra	33	Mo	23
1770	C	G	1	2	21	13	24	Vicra	34	Mo	24
1	B	F	2	3	22	13	25	Chandhana	35	We	25
B	AG	ED	3	4	23	13	26	Nandana	36	Th	26
2	F	C	4	5	24	13	27	Vijya	37	Fri	27
3	E	B	5	6	25	13	28	Jya	38	Sat	28
4	D	A	6	7	26	13	29	Manas	39	Sun	29
B	CB	GF	7	8	27	13	30	Pharanga	40	Mo	30
7	A	E	8	9	28	13	31	Chandhana	41	Th	31
8	G	D	9	10	29	13	32	Vicra	42	We	32
9	F	C	4880	1	30	13	33	Vicra	43	Th	33
1780	ED	BA	1	2	31	13	34	Sarmas	44	Sat	34
1	C	G	2	3	32	13	35	Pharanga	45	Sun	35
2	B	F	3	4	33	13	36	Sarmas	46	Mo	36
3	A	E	4	5	34	13	37	Sarmas	47	We	37
B	GF	DC	5	6	35	13	38	Sarmas	48	Th	38
5	E	B	6	7	36	13	39	Sarmas	49	Fri	39
6	D	A	7	8	37	13	40	Sarmas	50	Sat	40
7	C	G	8	9	38	13	41	Sarmas	51	Sun	41
B	BA	FE	9	10	39	13	42	Sarmas	52	Mo	42
9	G	D	4890	1	40	13	43	Sarmas	53	Th	43
1790	F	C	1	2	41	13	44	Sarmas	54	We	44
1	E	B	2	3	42	13	45	Sarmas	55	Th	45
B	DC	AG	3	4	43	13	46	Sarmas	56	Fri	46
2	B	F	4	5	44	13	47	Sarmas	57	Sat	47
3	A	E	5	6	45	13	48	Sarmas	58	Sun	48
4	G	D	6	7	46	13	49	Sarmas	59	Mo	49
B	FE	CB	7	8	47	13	50	Sarmas	60	Th	50
7	D	A	8	9	48	13	51	Sarmas	61	We	51
8	C	G	9	10	49	13	52	Sarmas	62	Th	52
9	B	F	4900	1	50	13	53	Sarmas	63	Fri	53
1800	AG	E	1	2	51	13	54	Sarmas	64	Sat	54

(*) The upper ones, printed in Italics, are those by the Saurish Siddhanta; the lower ones, printed in roman, are those by the Jyotish.

(†) Beginning of the 6th Cycle of Jupiter, Saurish Siddhanta.

XXV																				
I.	II.		III.	IV.	V.		VI.		VII.		VIII.		IX.		X.		XI.		XII.	
Christian years.	Domical Letter O. & A.	Domical Letter N. & S.	Years expired of the Cal. yug.	Years expired from the birth of Sathya-hita.	Years of the Cycle, Initialed.	Years of the Cycle of 60, Graha-parti (10).	Years of the Cycle of 60 years or Vatsaspati, Bengal reckoning.	Numerals.	Years of the Cycle of 60 years as reckoned South of the River Narmada.	Numerals.	Initial letter of the year.	Date in April N. & S.	Initial letter of the year.	Date in April N. & S.	Initial letter of the year.	Date in April N. & S.	Initial letter of the year.	Date in April N. & S.	Initial letter of the year.	Date in April N. & S.
1801	F	D	1002	1723	977	14	25	Angira	6	Darmati	55	Sat	11	Fri	10	B (3) 54 16 15	1207			
2	E	C	3	4	8	15	26	Srimat'ha	7	Dandabhi	56	Sun	12	Sun	11	(0) 9 47 30	8			
3	D	B	4	5	9	16	27	Blhara	8	Rudiradga	57	Mo	13	Mo	12	(1) 25 18 45	9			
B 4	CB	AG	5	6	980	14	28	Yusa	9	Ractascha	58	We	14	Tu	10	(2) 40 50 0	1210			
5	A	F	6	7	1	14	29	Dhata	10	Cradha	59	Th	15	We	11	B (3) 55 21 15	1			
6	G	E	7	8	2	15	30	Iswara	11	Cshya	60	Fri	16	Fri	12	(5) 1 32 30	2			
7	F	D	8	9	3	15	31	Bahudanya	12	Prabhara	1	Sat	17	Sat	13	(6) 27 23 45	3			
B 8	ED	CB	9	10	4	14	32	Pramat'hi	13	Vibhaya	2	Mo	18	Sun	10	(0) 42 59 0	4			
9	C	A	10	11	5	14	33	Vicrama	14	Sucha	3	Tu	19	Mo	11	B (1) 56 26 15	5			
1810	B	G	1	12	6	15	34	Braya	15	Pramoda	4	We	20	We	12	(3) 13 57 20	6			
1	A	F	2	13	7	15	35	Chitrab'ham	16	Prajapati	5	Th	21	Th	13	(4) 28 28 45	7			
B 2	GF	ED	3	14	8	14	36	Subhama	17	Angira	6	Sat	22	Fri	10	B (2) 45 0 0	8			
3	E	C	4	15	9	14	37	Tarana	18	Srimat'ha	7	Sun	23	Sun	11	(0) 0 31 15	9			
4	D	B	5	16	990	15	38	Parthiva	19	Dhara	8	Mo	24	Mo	12	(1) 16 2 30	1220			
5	C	A	6	17	1	15	39	Vyaya	20	Yusa	9	We	25	Tu	14	(2) 31 33 45	1			
B 6	BA	GF	7	18	2	14	40	Sarajit	21	Dhata	10	Th	26	We	10	B (3) 47 5 0	2			
7	G	E	8	19	3	14	41	Saradharit	22	Iswara	11	Fri	27	Fri	11	(3) 2 36 15	3			
8	F	D	9	20	4	15	42	Vicodhi	23	Bahudanya	12	Sat	28	Sat	12	(6) 18 7 30	4			
9	E	C	10	21	5	15	43	Vicrita	24	Pramat'hi	13	Mo	29	Sun	13	(0) 35 28 45	5			
1820	DC	BA	1	22	6	14	44	Chara	25	Vicrama	14	Tu	30	Mo	10	B (1) 49 10 0	6			
1	B	G	2	23	7	15	45	Nandana	26	Braya	15	We	31	We	11	(3) 4 41 15	7			
2	A	F	3	24	8	15	46	Vijya	27	Chitrab'ham	16	Th	32	Th	12	(4) 20 12 30	8			
3	G	E	4	25	9	15	47	Jya	28	Subhama	17	Sat	33	Fri	13	(5) 35 43 45	9			
B 4	FE	DC	5	26	1000	14	48	Manmat'ha	29	Tarana	18	Sun	34	Sat	10	B (6) 51 16 0	1230			
5	D	B	6	27	1	15	49	Dormat'ha	30	Parthiva	19	Mo	35	Mo	11	(1) 6 46 15	1			
6	C	A	7	28	2	15	50	Hemalakra	31	Vyaya	20	Tu	36	Tu	12	(2) 22 17 30	2			
7	B	G	8	29	3	15	51	Vilamya	32	Sarajit	21	Th	37	We	13	(3) 37 48 45	3			
B 8	AG	FE	9	30	4	14	52	Vicari	33	Saradharit	22	Fri	38	Th	10	B (4) 53 20 0	4			
9	F	D	10	31	5	15	53	Sarari	34	Vicodhi	23	Sat	39	Sat	11	(6) 8 51 15	5			
1830	E	C	1	32	6	15	54	Plava	35	Vicrita	24	Sun	40	Sun	12	(0) 24 22 30	6			
1	D	B	2	33	7	15	55	Subharit	36	Chara	25	Tu	41	Mo	13	(1) 39 53 45	7			
B 2	CB	AG	3	34	8	14	56	Subhama	37	Nandana	26	We	42	Tu	10	B (2) 55 25 0	8			
3	A	F	4	35	9	15	57	Cradhi	38	Vijya	27	Th	43	Th	11	(4) 10 56 15	9			
4	G	E	5	36	10	15	58	Vishwara	39	Jya	28	Fri	44	Fri	12	(5) 26 27 30	1240			
5	F	D	6	37	11	15	59	Parab'ha	40	Manmat'ha	29	Sun	45	Sat	13	(6) 41 58 45	1			
B 6	ED	CB	7	38	12	14	60	Plavanga	41	Dormat'ha	30	Mo	46	Sun	10	B (0) 57 30 0	2			
7	C	A	8	39	13	15	61	Cilaca	42	Hemalakra	31	Tu	47	Tu	11	(2) 13 1 15	3			
8	B	G	9	40	14	15	62	Somya	43	Vilamya	32	We	48	We	12	(3) 28 32 30	4			
9	A	F	10	41	15	15	63	Sadhama	44	Vicari	33	Fri	49	Th	13	(4) 44 3 45	5			
1840	GF	ED	1	42	16	14	64	Vicodharit	45	Sarari	34	Sat	50	Fri	10	B (5) 59 35 0	6			
1	E	C	2	43	17	15	65	Paridharit	46	Plava	35	Sun	51	Sun	11	(0) 15 6 15	7			
2	D	B	3	44	18	15	66	Pramat'hi	47	Subharit	36	Tu	52	Mo	12	(1) 30 37 30	8			
3	C	A	4	45	19	15	67	Angira	48	Subhama	37	We	53	Tu	13	B (2) 46 8 45	9			
B 4	BA	GF	5	46	20	14	68	Ractascha	49	Cradhi	38	Th	54	Th	14	(4) 1 40 0	1250			
5	G	E	6	47	21	15	69	Angira	50	Vishwara	39	Fri	55	Fri	15	(5) 17 11 15	1			
6	F	D	7	48	22	15	70	Plavanga	51	Parab'ha	40	Sun	56	Sat	16	(6) 32 42 30	2			
7	E	C	8	49	23	15	71	Cilaca	52	Plavanga	41	Mo	57	Sun	17	B (0) 48 13 45	3			
B 8	DC	BA	9	50	24	15	72	Somya	53	Cilaca	42	Tu	58	Tu	18	(2) 3 45 0	4			
9	B	G	10	51	25	15	73	Sadhama	54	Somya	43	We	59	We	19	(3) 18 16 15	5			
1850	A	F	1	52	26	15	74	Angira	55	Sadhama	44	Fri	60	Th	20	(4) 34 47 30	6			

(*) The upper numbers, printed in italics, are those by the Sarrasiddhanta; the lower ones, printed in roman, are those by the Jyotishika.

(*) Beginning of the 801 Cycle of Jupiter, Tellinga account.

I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.	X.	XI.	XII.					
Christian years.	Dominical Letter O. S.	Dominical Letter N. S.	Years expired of the Chit. yug.	Years expired from the birth of Sathya.	Years of the Cycle, the Cycle, Initial date.	Years of the Cycle of 60 years of the Hindu, Bengali reckoning.	Years of the Cycle of 60 years of the Hindu, Bengali reckoning.	Initial year of the Cycle of 60 years of the Hindu, Bengali reckoning.	Initial year of the Cycle of 60 years of the Hindu, Bengali reckoning.	Roots of beginnings of the Cycle of 60 years of the Hindu, Bengali reckoning.	Roots of beginnings of the Cycle of 60 years of the Hindu, Bengali reckoning.					
1351	G	E	4032	1773	27 15	75	Dundubhi	35	Viródhacrit	45	Sat	12	Fri	11	B (3) 50 18 45	1257
B 2	FE	DC	3	4	28 15	76	Rudrōdgari	36	Paridhāri	46			Sun	11	(0) 5 50 0	8
3	D	B	4	5	29 15	77	Rudrōdgari	37	Pramāṇi	47			Mo	11	(1) 21 21 15	9
4	C	A	5	6	30 15	78	Rudrōdgari	38	A'nanda	48	We	12	Tu	11	(2) 36 52 30	1200
5	B	G	6	7	31 15	79	Rudrōdgari	39	Rac'shina	49	Th	12	We	11	B (3) 52 23 45	1
B 6	AG	FE	7	8	32 15	80	Rudrōdgari	40	Anala	50			Fri	11	(3) 7 55 0	2
7	F	D	8	9	33 15	81	Rudrōdgari	41	Pingala	51			Sat	11	(4) 23 23 15	3
8	E	C	9	10	34 15	82	Rudrōdgari	42	Cālayueta	52	Mo	12	Sun	11	(5) 38 57 30	4
9	D	B	10	11	35 15	83	Rudrōdgari	43	Siddhāri	53	Tu	12	Mo	11	B (1) 54 25 45	5
1800	CB	AG	1	12	36 15	84	Rudrōdgari	44	Rac'shina	54	We	12	We	11	(6) 10 0 0	6
1	A	F	2	13	37 15	85	Rudrōdgari	45	Durmati	55	Th	12	Th	11	(7) 25 31 15	7
2	G	E	3	14	38 15	86	Rudrōdgari	46	Dundubhi	56	Sat	12	Fri	11	(8) 41 2 30	8
3	F	D	4	15	39 15	87	Rudrōdgari	47	Rudrōdgari	57	Sun	12	Sat	11	B (6) 56 33 45	9
B 4	ED	CB	5	16	40 15	88	Rudrōdgari	48	Rac'shina	58			Mo	11	(1) 12 5 0	1270
5	C	A	6	17	41 15	89	Rudrōdgari	49	Croḍhana	59			Tu	11	(2) 27 36 15	1
6	B	G	7	18	42 15	90	Rudrōdgari	50	Cshya	60	Th	12	We	11	(3) 43 7 30	2
7	A	F	8	19	43 15	1	Rudrōdgari	51	Prabhava(?)	1	Fri	12	Th	11	B (4) 58 38 45	3
B 8	GF	ED	9	20	44 15	2	Rudrōdgari	52	Vibhava	2			Sat	11	(5) 14 10 0	4
9	E	C	10	21	45 15	3	Rudrōdgari	53	Sucra	3			Sun	11	(6) 29 41 15	5
1870	D	B	11	22	46 15	4	Rudrōdgari	54	Pramoda	4	Tu	12	Mo	11	B (1) 45 12 30	6
1	C	A	12	23	47 15	5	Rudrōdgari	55	Prajapati	5			We	12	(2) 0 43 45	7
B 2	BA	GF	1	24	48 15	6	Rudrōdgari	56	Aogira	6			Th	11	(3) 16 15 0	8
3	G	E	2	25	49 15	7	Rudrōdgari	57	Srimuc'ha	7	Sat	12	Fri	11	(4) 31 26 15	9
4	F	D	3	26	50 15	8	Rudrōdgari	58	Bhāva	8	Sun	12	Sat	11	B (6) 47 17 30	1280
5	E	C	4	27	51 15	9	Rudrōdgari	59	Yava	9			Mo	12	(1) 2 48 45	1
B 6	DC	BA	5	28	52 15	10	Rudrōdgari	60	Dhārā	10			Tu	12	(2) 18 50 0	2
7	B	G	6	29	53 15	11	Rudrōdgari	1	Isvara	11	Th	12	We	11	(3) 33 51 15	3
8	A	F	7	30	54 15	12	Rudrōdgari	2	Bahudanya	12	Fri	12	Th	11	B (3) 49 22 30	4
9	G	E	8	31	55 15	13	Rudrōdgari	3	Pramāṇi	13			Sat	12	(4) 4 53 45	5
1880	FE	DC	9	32	56 15	14	Rudrōdgari	4	Vicrama	14			Sun	11	(5) 20 25 0	6
1	D	B	10	33	57 15	15	Rudrōdgari	5	Ucāya	15	Tu	12	Mo	11	(6) 35 56 15	7
2	C	A	11	34	58 15	16	Rudrōdgari	6	Chitrab'hana	16	We	12	Tu	11	B (2) 51 27 30	8
3	B	G	12	35	59 15	17	Rudrōdgari	7	Sābhāna	17			Th	12	(3) 6 58 45	9
B 4	AG	FE	1	36	60 15	18	Rudrōdgari	8	Tārana	18			Fri	11	(4) 22 30 0	1290
5	F	D	2	37	61 15	19	Rudrōdgari	9	Pārthiva	19	Sun	12	Sat	11	(5) 38 1 15	1
6	E	C	3	38	62 15	20	Rudrōdgari	10	Vyāsa	20	Mo	12	Sun	11	B (0) 53 22 30	2
7	D	B	4	39	63 15	21	Rudrōdgari	11	Sarvajit	21			Tu	12	(1) 0 3 45	3
B 8	CB	AG	5	40	64 15	22	Rudrōdgari	12	Sarvadhārī	22			We	11	(2) 16 35 0	4
9	A	F	6	41	65 15	23	Rudrōdgari	13	Vicrōdhi	23	Fri	12	Th	11	(3) 31 36 15	5
1890	G	E	7	42	66 15	24	Rudrōdgari	14	Vicrīta	24	Sat	12	Fri	11	B (5) 55 37 30	6
1	F	D	8	43	67 15	25	Rudrōdgari	15	Chāra	25			Sun	12	(6) 11 8 45	7
B 2	ED	CB	9	44	68 15	26	Rudrōdgari	16	Nandana	26			Mo	11	(1) 26 40 0	8
3	C	A	10	45	69 15	27	Rudrōdgari	17	Vijya	27	We	12	Tu	11	(2) 42 11 15	9
4	B	G	11	46	70 15	28	Rudrōdgari	18	Jya	28	Th	12	We	11	B (3) 57 42 30	1300
5	A	F	12	47	71 15	29	Rudrōdgari	19	Manmat'ha	29			Fri	12	(4) 13 13 45	1
B 6	GF	ED	1	48	72 15	30	Rudrōdgari	20	Durmat'ha	30			Sat	11	(5) 28 45 0	2
7	E	C	2	49	73 15	31	Rudrōdgari	21	Hemalāva	31	Mo	12	Sun	11	(6) 44 16 15	3
8	D	B	3	50	74 15	32	Rudrōdgari	22	Vīlāva	32	Tu	12	Mo	11	B (1) 59 47 30	4
9	C	A	4	51	75 15	33	Rudrōdgari	23	Vicārī	33			We	12	(2) 15 18 45	5
1900	BA	G	5	52	76 15	34	Rudrōdgari	24	Sarvajit	34	Fri	12	Th	12	(3) 30 50 0	6

(*) The upper numbers, printed in Italics, are those by the Saurish Siddhānta; the lower ones, printed in roman, are those by the Jyauṣṭya.

(1) Beginning of the 5th Cycle of Jupiter, Saurish Siddhānta.

(2) Beginning of the 5th Cycle, Tellinga account.

SECOND CHRONOLOGICAL TABLE showing the principal circumstances of the common Lunar-solar year in use in the Peninsula of India, and the concurring Fuzul or revenue years.

I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.	X.	XI.	XII.		
Christian year.	Years elapsed of the Cal year.	Charakas of the year.	Last full moon in the Lunar-solar year.	Date of the last moon conjunction in day.	Date in China of solar year.	Sydera-dora-tion of China.	Civil division of China.	Solar Akargana, or Yughia, to be counted from Friday.	Lunar Akargana to be counted from Thursday.	Years of the Vicramaditya.	Firetee years elapsed.	Initial date, O. S.	Final date, N. S.
B 1600	4701	A	Wednes	15 Mar	(*) 0	30	30	DATE. D. M. Y. P. 1717078 54 35 0	DATE. 1717037	687	1000	30	10
1	2		Monday	2 April	-27	31	30	1717444 10 6 15	1717410	8	1010	30	10
2	3		Saturday	23 Mar	10	30	30	1717809 23 37 30	1717775	9	1	30	10
3	4	A	Wednes	12 Mar	5	30	31	1718174 41 8 45	1718140	1000	2	1	11
B 4	5		Tuesday	30 Mar	-24	30	30	1718539 56 40 0	1718505	1	3	30	10
5	6	A	Saturday	19 Mar	-13	31	30	1718905 12 11 15	1718871	2	4	30	10
6	7		Thursday	9 Mar	2	30	30	1719270 27 42 30	1719236	3	5	30	10
7	8		Wednes	28 Mar	21	30	31	1719635 43 13 45	1719601	4	6	1	11
B 8	9	A	Sunday	16 Mar	-10	30	30	1720000 58 45 0	1719966	5	7	30	10
9	10		Saturday	4 April	-29	31	30	1720365 14 16 15	1720331	6	8	30	10
1510	1		Wednes	23 Mar	17	30	30	1720731 29 47 30	1720718	7	9	30	10
1	2	A	Monday	14 Mar	7	30	31	1721096 45 18 45	1721073	8	1000	1	11
B 2	3		Sunday	1 April	-30	31	30	1721462 0 50 0	1721447	9	1	30	10
3	4	A	Thursday	21 Mar	-15	31	30	1721827 16 21 15	1721811	1070	2	30	10
4	5		Monday	10 Mar	3	30	31	1722192 31 52 30	1722165	1	3	30	10
5	6		Sunday	29 Mar	22	30	31	1722557 47 23 45	1722519	2	4	1	11
B 6	7	A	Friday	18 Mar	-14	31	30	1722923 2 55 0	1722904	3	5	30	10
7	8		Wednes	6 April	-30	31	30	1723288 18 26 15	1723287	4	6	30	10
8	9		Monday	26 Mar	12	30	31	1723653 33 57 30	1723642	5	7	1	11
9	10	A	Friday	15 Mar	9	30	31	1724018 49 28 45	1723996	6	8	1	11
B 1020	1		Thursday	2 April	-27	31	30	1724384 5 0 0	1724380	7	9	30	10
1	2		Monday	22 Mar	15	30	30	1724749 20 31 15	1724734	8	1000	30	10
2	3	A	Saturday	12 Mar	5	30	31	1725114 36 2 30	1725089	9	1	1	11
3	4		Friday	31 Mar	24	30	31	1725479 51 53 45	1725473	1680	2	1	11
B 4	5	A	Tuesday	19 Mar	-13	31	30	1725845 7 5 0	1725827	1	3	30	10
5	6		Saturday	8 Mar	1	30	30	1726210 22 36 15	1726181	2	4	30	10
6	7		Friday	27 Mar	20	30	31	1726575 38 7 30	1726568	3	5	1	11
7	8	A	Wednes	17 Mar	-10	30	30	1726940 53 38 45	1726920	4	6	1	11
8	9		Tuesday	4 April	-29	31	30	1727305 9 10 0	1727301	5	7	30	10
9	10		Saturday	24 Mar	17	30	30	1727671 24 41 15	1727658	6	8	30	10
1530	1	A	Wednes	13 Mar	6	30	31	1728036 40 12 30	1728012	7	9	1	11
1	2		Tuesday	1 April	-25	30	30	1728401 55 43 45	1728396	8	1040	1	11
B 2	3	A	Sunday	21 Mar	-15	31	30	1728767 11 15 0	1728761	9	1	30	10
3	4		Thursday	10 Mar	5	30	30	1729132 26 46 15	1729105	1690	2	30	10
4	5		Wednesday	29 Mar	22	30	31	1729497 42 17 30	1729489	1	3	1	11
5	6	A	Sunday	18 Mar	-11	30	30	1729862 57 48 45	1729843	2	4	1	11
B 6	7		Saturday	5 April	-30	31	30	1730227 13 50 0	1730217	3	5	30	10
7	8		Thursday	25 Mar	29	30	30	1730593 28 51 15	1730582	4	6	30	10
8	9	A	Monday	15 Mar	8	30	31	1730958 44 22 30	1730936	5	7	1	11
9	10		Sunday	3 April	-27	30	30	1731323 59 53 45	1731310	6	8	1	11
B 1640	1		Thursday	22 Mar	-16	31	30	1731689 15 25 0	1731674	7	9	30	10
1	2	A	Tuesday	12 Mar	5	30	31	1732054 30 56 15	1732029	8	1000	30	10
2	3		Sunday	30 Mar	23	30	31	1732419 46 27 30	1732412	9	1	1	11
3	4	A	Friday	20 Mar	-13	31	30	1732783 1 58 45	1732767	1700	2	1	11
B 4	5		Thursday	8 Mar	-2	31	30	1733150 17 30 0	1733121	1	3	30	10
5	6		Monday	27 Mar	20	30	31	1733515 33 1 15	1733506	2	4	30	10
6	7	A	Friday	16 Mar	9	30	31	1733880 48 32 30	1733859	3	5	1	11
7	8		Thursday	4 April	-29	31	30	1734246 4 3 45	1734243	4	6	1	11
B 8	9		Tuesday	24 Mar	-19	31	30	1734611 19 35 0	1734592	5	7	30	10
9	10	A	Saturday	13 Mar	6	30	31	1734976 25 6 15	1734952	6	8	1	11
1650	1		Friday	1 April	-25	30	30	1735341 50 37 30	1735336	7	9	1	11

(*) The stroke — before the figure, indicates that the Civil Solar date is one less.

I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.	X.	XI.	XII.		
Christian years.	Years expired of the Calli yug.	Character of the year.	Last feria to the last solar year.	Date of the last mean conjunction in do.	Date in China of solar year.	Sydera- tion of China.	Civil duration of China.	Solar Abargana, or Yugadia, to be counted from Friday.	Last solar Abargana to be counted from Thursday.	Years of the Viraquitya.	Years expired.	Initial date, O. S.	Initial date, N. S.
					Day			DATE. S. P. F.	DATE.			June July	July
B 1651	4752	A	Tuesday	21 Mar	-14	31	30	1735707 6 8 45	1735690	1708	1060	1	11
	3		Sunday	10 Mar	3	30	30	1736072 21 40 0	1736045	9	1	30	10
	4		Saturday	29 Mar	20	30	31	1736437 37 11 13	1736420	1710	2	1	11
	5	A	Wednesday	18 Mar	-11	30	30	1736802 52 42 30	1736783	1	3	1	11
	6		Tuesday	6 April	-30	31	30	1737168 8 13 45	1737167	2	4	1	11
B 1656	7		Saturday	25 Mar	13	30	30	1737533 23 45 0	1737521	3	5	30	10
	8	A	Thursday	15 Mar	8	30	31	1737898 39 16 15	1737876	4	6	1	11
	9		Tuesday	2 April	-26	30	30	1738263 54 47 30	1738250	5	7	1	11
B 1660	4760	A	Sunday	23 Mar	-10	31	30	1738629 10 18 45	1738614	6	8	1	11
	1		Thursday	11 Mar	4	30	30	1738994 25 30 0	1738968	7	9	30	10
	2		Wednesday	39 Mar	23	30	31	1739359 41 21 15	1739352	8	1070	1	11
	3	A	Sunday	19 Mar	-12	30	30	1739724 56 52 30	1739705	9	1	1	11
	4		Saturday	7 April	-31	31	30	1740090 12 23 45	1740090	1720	2	1	11
B 1664	5		Thursday	27 Mar	20	30	30	1740455 27 55 0	1740455	1	3	30	10
	6	A	Monday	16 Mar	9	30	31	1740820 43 26 15	1740799	2	4	1	11
	7		Sunday	4 April	-28	30	30	1741185 58 57 30	1741183	3	5	1	11
B 1668	8		Thursday	24 Mar	-17	31	30	1741551 14 28 45	1741537	4	6	1	11
	9	A	Tuesday	13 Mar	6	30	31	1741916 30 0 0	1741892	5	7	30	10
	10		Monday	1 April	25	30	31	1742281 45 31 15	1742270	6	8	1	11
1670	1	A	Friday	21 Mar	-14	31	30	1742647 1 2 30	1742630	7	9	1	11
	2		Tuesday	10 Mar	-3	31	30	1743012 16 33 45	1742984	8	1080	1	11
B 1674	3		Monday	28 Mar	21	30	31	1743377 32 5 0	1743368	9	1	30	10
	4	A	Saturday	18 Mar	11	30	31	1743742 47 36 15	1743723	1730	2	1	11
	5		Friday	6 April	-30	31	30	1744108 3 7 30	1744107	1	3	1	11
B 1678	6		Tuesday	26 Mar	-19	31	30	1744473 18 38 45	1744461	2	4	1	11
	7	A	Saturday	14 Mar	7	30	31	1744838 34 10 0	1744815	3	5	1	11
	8		Friday	2 April	26	30	31	1745203 49 41 15	1745109	4	6	1	11
	9		Wednesday	23 Mar	-16	31	30	1745569 5 12 30	1745554	5	7	1	11
	10	A	Sunday	12 Mar	4	30	30	1745934 20 43 45	1745908	6	8	1	11
B 1682	1	(*)	Saturday	30 Mar	23	30	31	1746299 36 15 0	1746292	7	9	1	11
	2	AC	Wednesday	19 Mar	-12	30	30	1746664 51 46 15	1746646	8	1090	1	11
	3		Tuesday	7 April	-31	31	30	1747030 7 17 30	1747030	9	1	1	11
B 1686	4		Saturday	27 Mar	19	30	30	1747395 22 48 45	1747384	1740	2	1	11
	5	A	Thursday	16 Mar	9	30	31	1747760 38 20 0	1747739	1	3	1	11
	6		Wednesday	4 April	-28	30	30	1748125 53 51 15	1748123	2	4	1	11
	7		Sunday	24 Mar	-17	31	30	1748491 9 22 30	1748477	3	5	1	11
	8	A	Thursday	13 Mar	5	30	30	1748856 24 53 45	1748831	4	6	1	11
B 1690	9		Wednesday	31 Mar	24	30	31	1749221 40 25 0	1749215	5	7	1	11
	10	A	Monday	21 Mar	-14	30	30	1749586 55 56 15	1749570	6	8	1	11
	11		Friday	10 Mar	-3	31	30	1749952 11 27 30	1749924	7	9	1	11
B 1694	12		Thursday	29 Mar	21	30	30	1750317 26 58 45	1750308	8	1100	1	11
	13	A	Monday	17 Mar	19	30	31	1750682 42 30 0	1750662	9	1	1	11
	14		Sunday	5 April	-29	30	30	1751047 58 1 15	1751046	1750	2	1	11
	15		Friday	26 Mar	-19	31	30	1751413 13 32 30	1751401	1	3	1	11
	16	A	Tuesday	15 Mar	7	30	30	1751778 29 3 45	1751755	2	4	1	11
B 1698	17		Monday	2 April	20	30	31	1752143 44 35 0	1752139	3	5	1	11
	18	A	Friday	22 Mar	-15	31	30	1752509 0 6 15	1752493	4	6	1	11
	19		Wednesday	12 Mar	-5	31	30	1752874 15 37 30	1752858	5	7	1	11
	20		Tuesday	31 Mar	23	30	31	1753239 31 8 45	1753232	6	8	1	11
1700	1	A	Saturday	20 Mar	12	30	31	1753604 46 40 0	1753586	7	9	1	12

(*) The expunged month in the 4783d year of the Calli yug. current, fell on Agrahayan otherwise Margashirsa, and the intercalated month was Aresana and Chitra, of the ensuing year.

Second Chronological Table, continued.

Second Chronological Table, continued.													
I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.	X.	XI.	XII.		
Christian year.	Years expired of the Ch. Yag.	Character of the year.	Last feria in the lunar-solar year.	Date of the last moon conjunction in do.	Date in China of solar year.	Hydrocalender of China.	Civil duration of China.	Solar Aberration, or Yagulis, to be counted from Friday.	Lunar-solar Aberration to be counted from Thursday.	Years of Era of the Yagulis.	Twelve years expired.	Initial date, O. S.	Initial date, N. S.
						Byd.		DATE. G. Y. P.	DATE.			July	July
1701	1802		Friday	9 April	—31	31	30	1753070 2 11 15	1753270	1708	1110	1	12
2	3		Tuesday	28 Mar	—20	31	30	1754133 17 42 30	1754331	9	2	1	12
3	4	A	Saturday	17 Mar	8	30	31	1754700 33 13 45	1754678	1700	2	1	12
4	5		Friday	4 April	27	30	31	1755065 48 45 0	1755002	1	2	1	12
5	6		Wednesday	23 Mar	—17	31	30	1755431 4 10 15	1755417	2	3	1	12
6	7	A	Sunday	14 Mar	—6	31	30	1755796 19 47 30	1755771	3	4	2	13
7	8		Saturday	2 April	24	30	31	1756161 55 18 45	1756153	4	5	1	12
8	9	A	Wednesday	21 Mar	—13	30	30	1756526 50 50 0	1756509	5	6	1	12
1710	1810		Monday	11 Mar	—3	31	30	1756892 6 21 15	1756864	6	7	1	12
1	2	A	Saturday	29 Mar	20	30	30	1757257 21 52 30	1757247	7	8	1	12
2	3		Thursday	19 Mar	10	30	31	1757622 37 23 45	1757602	8	9	2	13
3	4		Wednesday	6 April	—29	30	30	1757987 52 55 0	1757986	9	1	1	12
4	5	A	Sunday	26 Mar	—18	31	30	1758353 8 26 15	1758340	1770	2	1	12
5	6		Thursday	15 Mar	—6	30	30	1758718 23 57 30	1758694	1	3	1	12
6	7	A	Wednesday	3 April	25	30	31	1759083 39 23 45	1759078	2	4	2	13
			Monday	23 Mar	—15	30	30	1759448 55 0 0	1759433	3	5	1	12
7	8		Friday	12 Mar	—4	31	30	1759814 10 31 15	1759787	4	6	1	12
8	9		Thursday	31 Mar	22	30	30	1760179 26 2 30	1760171	5	7	1	12
9	10	A	Tuesday	21 Mar	11	30	31	1760544 41 33 45	1760525	6	8	2	13
1720	1		Saturday	9 Mar	—1	30	30	1760909 57 5 0	1760880	7	9	1	12
1	2	A	Friday	28 Mar	—20	31	30	1761275 12 36 15	1761254	8	10	1	12
2	3		Tuesday	17 Mar	—9	30	30	1761640 28 7 30	1761618	9	1	1	12
3	4		Monday	5 April	27	30	31	1762005 43 38 45	1762002	1780	2	2	13
4	5		Friday	24 Mar	—16	30	30	1762370 59 10 0	1762356	1	3	1	12
5	6	A	Wednesday	14 Mar	—6	31	30	1762736 14 41 15	1762711	2	4	1	12
6	7		Tuesday	2 April	24	30	31	1763101 30 12 30	1763093	3	5	1	12
7	8	A	Saturday	23 Mar	13	30	31	1763466 45 43 45	1763449	4	6	2	13
8	9		Wednesday	10 Mar	—2	31	30	1763832 1 15 0	1763803	5	7	1	12
9	10		Tuesday	29 Mar	—21	31	30	1764197 16 46 15	1764187	6	8	1	12
1730	1	A	Sunday	19 Mar	—10	30	31	1764562 32 17 30	1764542	7	9	1	12
1	2		Friday	9 April	29	30	31	1764927 47 48 45	1764923	8	10	2	13
2	3		Wednesday	28 Mar	—18	31	30	1765293 3 20 0	1765280	9	1	1	12
3	4	A	Sunday	15 Mar	—7	31	30	1765658 18 51 15	1765634	1790	2	1	12
4	5		Saturday	3 April	25	30	31	1766023 34 22 30	1766018	1	3	2	12
5	6	A	Wednesday	23 Mar	14	30	31	1766388 49 53 45	1766372	2	4	2	13
6	7		Monday	19 Mar	—4	31	30	1766754 5 25 0	1766727	3	5	1	12
7	8		Sunday	31 Mar	22	30	30	1767119 20 56 15	1767111	4	6	1	12
8	9	A	Thursday	20 Mar	11	30	31	1767484 36 27 30	1767465	5	7	2	13
9	10		Wednesday	8 April	—30	30	30	1767849 51 58 45	1767849	6	8	2	13
1740	1		Sunday	27 Mar	—19	31	30	1768215 7 30 0	1768203	7	9	1	12
1	2	A	Friday	17 Mar	—8	30	30	1768580 23 1 15	1768558	8	10	1	12
2	3		Thursday	5 April	27	30	31	1768945 38 32 30	1768942	9	1	2	13
3	4		Monday	25 Mar	—16	30	30	1769310 54 3 45	1769296	1800	2	2	13
4	5	A	Friday	13 Mar	—5	31	30	1769676 9 55 0	1769650	1	3	1	12
5	6		Thursday	1 April	23	30	30	1770041 25 6 15	1770034	2	4	1	12
6	7	A	Tuesday	22 Mar	13	30	31	1770406 40 37 30	1770389	3	5	2	13
7	8		Saturday	11 Mar	—2	31	30	1770771 56 8 45	1770743	4	6	2	13
8	9		Sunday	29 Mar	—21	31	30	1771137 11 40 0	1771127	5	7	1	12
9	10	A	Friday	18 Mar	—9	30	30	1771502 27 11 15	1771481	6	8	1	12
1750	1		Tuesday	16 Mar	28	30	31	1771867 42 42 30	1771869	7	9	2	13
			Monday	6 April									

I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.	X.	XI.	XII.	
Christian years.	Years expired at the calling of the Comet.	Character of the year.	Left feria to the lunar year.	Date of the last urban conjunction in do.	Date in China of solar year.	Superaddition to China.	Civil duration of China.	Solar Aberration, or Yugaia, to be counted from Friday.	Solar Aberration to be counted from Thursday.	Years of the Varamidra.	Years years expired.	Total days, B. C.
1751	4862		Saturday	27 Mar	Syd.	18	30	1772232 58 13 43	1772232	1808	1160	13
2	3	A	Wednesday	15 Mar	— 7	31	30	1772598 12 45 0	1772574	9	1	12
3	4		Thursday	3 April	— 25	30	30	1772963 23 16 15	1772928	1810	2	12
4	5	A	Saturday	23 Mar	— 15	30	31	1773329 44 47 30	1773312	1	3	13
5	6		Thursday	13 Mar	— 4	31	30	1773694 0 18 43	1773667	2	4	13
6	7		Tuesday	30 Mar	— 22	31	30	1774059 15 30 0	1774030	3	5	12
7	8	A	Sunday	20 Mar	— 11	30	31	1774424 31 21 15	1774405	4	6	12
8	9		Saturday	8 April	— 30	30	31	1774789 46 32 30	1774789	5	7	13
9	1800		Wednesday	23 Mar	— 10	31	30	1775155 2 23 43	1775143	6	8	13
1760	1	A	Sunday	16 Mar	— 8	31	30	1775520 17 35 0	1775497	7	9	12
1	2		Saturday	4 April	— 25	30	31	1775885 33 28 15	1775831	8	1170	12
2	3		Thursday	25 Mar	— 16	30	31	1776250 49 57 30	1776236	9	1	13
3	4	A	Monday	14 Mar	— 5	31	30	1776616 4 38 45	1776590	1820	2	13
4	5		Sunday	1 April	— 24	31	30	1776981 20 0 0	1776974	1	3	12
5	6	A	Thursday	21 Mar	— 12	30	31	1777346 35 31 15	1777338	2	4	13
6	7		Tuesday	11 Mar	— 2	30	30	1777711 51 2 30	1777683	3	5	13
7	8		Monday	30 Mar	— 21	31	30	1778077 6 33 45	1778067	4	6	13
8	9	A	Friday	18 Mar	— 9	30	30	1778442 22 5 0	1778321	5	7	12
9	4870		Thursday	6 April	— 28	30	31	1778807 37 56 15	1778805	6	8	13
1770	1		Monday	26 Mar	— 17	30	30	1779172 53 7 30	1779159	7	9	13
1	2	A	Saturday	16 Mar	— 7	31	30	1779538 8 38 45	1779514	8	1180	13
2	3		Friday	3 April	— 25	30	30	1779903 24 10 0	1779898	9	1	12
3	4	A	Tuesday	23 Mar	— 14	30	31	1780268 39 41 15	1780252	1530	2	13
4	5		Saturday	12 Mar	— 3	30	30	1780633 55 12 30	1780606	1	3	13
5	6		Friday	31 Mar	— 22	31	30	1780999 10 43 45	1780990	2	4	13
6	7	A	Wednesday	20 Mar	— 11	30	30	1781364 26 15 0	1781345	3	5	12
7	8		Monday	7 April	— 29	30	31	1781729 41 46 15	1781728	4	6	13
8	9		Saturday	28 Mar	— 19	30	30	1782094 57 17 30	1782083	5	7	13
9	4880	A	Wednesday	17 Mar	— 8	31	30	1782460 12 48 45	1782437	6	8	13
1780	1		Tuesday	4 April	— 26	30	30	1782825 28 20 0	1782821	7	9	12
1	2		Saturday	24 Mar	— 15	30	31	1783190 43 51 15	1783175	8	1190	13
2	3	A	Thursday	14 Mar	— 5	30	30	1783555 59 22 30	1783530	9	1	13
3	4		Wednesday	2 April	— 24	31	30	1783921 14 53 45	1783914	1840	2	13
4	5	A	Sunday	21 Mar	— 12	30	31	1784286 30 25 0	1784268	1	3	13
5	6		Thursday	10 Mar	— 1	30	31	1784651 45 56 15	1784624	2	4	13
6	7		Wednesday	29 Mar	— 20	31	30	1785017 1 47 30	1785008	3	5	12
7	8	A	Monday	19 Mar	— 10	31	30	1785382 16 58 45	1785361	4	6	13
8	9		Sunday	6 April	— 28	30	31	1785747 32 30 0	1785745	5	7	12
9	4890		Thursday	26 Mar	— 17	30	31	1786112 48 1 15	1786099	6	8	13
1790	1	A	Monday	15 Mar	— 6	31	30	1786478 3 32 30	1786453	7	9	13
1	2		Sunday	3 April	— 25	31	30	1786843 19 3 45	1786837	8	1200	13
2	3	A	Friday	23 Mar	— 14	30	31	1787208 34 35 0	1787192	9	1	13
3	4		Tuesday	12 Mar	— 3	30	31	1787573 50 16 15	1787546	1850	2	13
4	5		Monday	31 Mar	— 22	31	30	1787939 5 37 30	1787930	1	3	13
5	6	A	Friday	20 Mar	— 10	30	30	1788304 21 8 45	1788283	2	4	12
6	7		Thursday	7 April	— 29	30	31	1788669 36 40 0	1788668	3	5	13
7	8		Wednesday	28 Mar	— 19	30	30	1789034 52 11 15	1789023	4	6	13
8	9	A	Saturday	17 Mar	— 8	31	30	1789400 7 42 30	1789377	5	7	13
9	4900		Friday	5 April	— 26	30	30	1789765 23 13 45	1789761	6	8	13
1800	1		Thursday	25 Mar	— 15	30	31	1790130 38 45 0	1790113	7	9	14

I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.	X.	XI.	XII.
Christian year.	Years expired of the Coll' year.	Character of the year.	Last feria in the lunation year.	Date of the last new conjunction in do.	Date in China of solar year.	Subserved duration of China.	Civil duration of China.	Solar Aberration, or Yucalla, to be counted from Friday.	Luni-solar Aberration, to be counted from Thursday.	Years of sun Viceroyalty.	Years expired.
1801	4992	A	Sunday	15 Mar	Syd. 5	30	30	1793495 54 18 15	1790470	1858	1210
10	3		Friday	2 Apr	23	31	30	1790861 9 47 30	1790833	9	1 14
3	4	A	Wednes	23 Mar	12	30	30	1791226 25 18 45	1791208	1860	2 14
4	5		Sunday	11 Mar	1	30	31	1791501 40 50 0	1791552	1	3 14
5	6		Saturday	30 Mar	30	30	30	1791936 56 21 15	1791946	2	4 14
6	7	A	Wednes	19 Mar	0	31	30	1792342 11 52 30	1792100	3	5 14
7	8		Tuesday	7 Apr	27	30	30	1792687 27 23 45	1792684	4	6 14
8	9		Sunday	27 Mar	17	30	31	1793052 42 55 0	1793039	5	7 14
1810	4910	A	Thursday	16 Mar	6	30	30	1793417 58 26 15	1793383	6	8 14
1	1		Wednes	4 April	25	31	30	1793783 13 57 30	1793777	7	9 14
2	2	A	Sunday	24 Mar	13	30	30	1794148 29 28 45	1794131	8	1820 14
3	3		Friday	13 Mar	3	30	31	1794513 45 0 0	1794486	9	1 14
4	4		Thursday	1 April	22	31	30	1794879 0 31 15	1794870	1870	2 14
5	5	A	Monday	21 Mar	11	31	30	1795244 16 2 30	1795224	1	3 14
6	6		Sunday	9 April	29	30	31	1795609 31 33 45	1795608	2	4 14
7	7		Thursday	28 Mar	18	30	31	1795974 47 5 0	1795962	3	5 14
8	8	A	Tuesday	18 Mar	8	31	33	1796340 2 36 15	1796317	4	6 14
9	9		Sunday	5 April	26	31	30	1796705 18 7 30	1796700	5	7 14
1820	4920	A	Friday	26 Mar	15	30	31	1797070 33 38 45	1797053	6	8 14
1	1		Tuesday	14 Mar	4	30	31	1797435 49 10 0	1797409	7	9 14
2	2	(*)	Monday	2 April	23	31	30	1797801 4 41 15	1797793	8	1230 14
3	3	AC	Saturday	23 Mar	13	31	30	1798166 20 12 30	1798148	9	1 14
4	4		Wednes	12 Mar	1	30	31	1798531 36 43 45	1798502	1880	2 14
5	5		Tuesday	30 Mar	20	30	31	1798896 51 15 0	1798886	1	3 14
6	6	A	Saturday	19 Mar	9	31	30	1799262 6 46 15	1799240	2	4 14
7	7		Friday	7 April	27	30	30	1799627 22 17 30	1799624	3	5 14
8	8		Tuesday	27 Mar	16	30	31	1799992 37 48 45	1799978	4	6 14
9	9	A	Sunday	18 Mar	6	30	30	1800357 53 20 0	1800333	5	7 14
1830	4930		Saturday	4 April	25	31	30	1800723 8 31 15	1800717	6	8 14
1	1	A	Wednesday	24 Mar	13	30	30	1801088 24 22 30	1801071	7	9 14
2	2		Sunday	13 Mar	2	30	31	1801453 39 33 45	1801425	8	1240 15
3	3		Saturday	31 Mar	21	30	30	1801818 55 25 0	1801809	9	1 14
4	4	A	Thursday	21 Mar	11	31	30	1802184 10 56 15	1802164	1890	2 14
5	5		Wednesday	9 April	29	30	30	1802549 26 27 30	1802548	1	3 14
6	6		Sunday	29 Mar	18	30	31	1802914 41 58 45	1802902	2	4 14
7	7	A	Thursday	17 Mar	7	30	30	1803279 57 30 0	1803256	3	5 14
8	8		Wednesday	5 April	26	31	30	1803645 13 1 15	1803640	4	6 14
9	9	A	Monday	26 Mar	15	30	30	1804010 28 32 30	1803995	5	7 14
1840	4940		Friday	15 Mar	4	30	31	1804375 44 3 45	1804349	6	8 14
1	1		Thursday	2 April	23	30	30	1804740 59 35 0	1804733	7	9 14
2	2	A	Monday	22 Mar	12	31	30	1805106 15 6 15	1805087	8	1250 14
3	3		Saturday	12 Mar	1	30	31	1805471 30 37 30	1805442	9	1 14
4	4		Thursday	30 Mar	19	30	31	1805836 46 8 45	1805822	1900	2 14
5	5	A	Tuesday	19 Mar	9	31	30	1806202 1 40 0	1806180	1	3 14
6	6		Monday	7 April	23	31	30	1806567 17 11 15	1806564	2	4 14
7	7		Friday	27 Mar	16	30	31	1806932 32 42 30	1806918	3	5 14
8	8	A	Tuesday	16 Mar	5	30	31	1807297 48 13 45	1807272	4	6 14
9	9		Monday	3 April	24	31	30	1807663 3 45 0	1807650	5	7 14
1850	4950		Saturday	24 Mar	14	31	30	1808028 19 16 15	1808011	6	8 14
1	1	A	Wednesday	13 Mar	2	30	31	1808393 34 47 30	1808369	7	9 14

(*) The month which is expunged is Agrahayana or Margashira. Those which are expunged are Aswina, and Chaitra the first of the ensuing year.

Second Chronological Table, continued.

I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.	X.	XI.	XII.	
Christian years.	Years expired of the Calving	Character of the year.	Last feria in the Lunar year.	Date of the last mean conjunction in do.	Date in China of solar year.	Hydrological type of China.	Calil duration of China.	Solar Abargana, or Yagata, to be counted from Friday.	Lunar- under Abargana to be counted from Thursday.	Years of Asia Vietnam.	Years expired of the Calving.	Initial date, N. S.
1851	4252		Tuesday	1 April	21	30	31	1808758 50 18 45	1808749	1908	1260	15
2	3	A	Saturday	20 Mar	-10	31	30	1809121 5 50 0	1809103	9	1	14
3	4		Friday	8 April	28	30	30	1809480 21 21 15	1809467	1010	2	14
4	5		Wednes	29 Mar	15	30	31	1809854 36 52 30	1809842	1	3	15
5	6	A	Sunday	18 Mar	-7	30	30	1810219 52 43 45	1810199	2	4	15
6	7		Saturday	5 April	-24	31	30	1810585 7 55 0	1810580	3	5	14
7	8	A	Wednes	25 Mar	14	30	30	1810950 23 25 15	1810931	4	6	14
8	9		Monday	15 Mar	4	30	31	1811315 38 57 30	1811281	5	7	15
9	1960		Sunday	5 April	-23	30	30	1811680 54 29 45	1811673	6	8	15
1860	1	A	Thursday	22 Mar	-12	31	30	1812046 10 0 0	1812027	7	9	14
1	2		Wednes	10 April	30	30	30	1812411 25 31 15	1812411	8	1970	14
2	3		Sunday	30 Mar	19	30	31	1812776 41 2 30	1812759	9	1	15
3	4	A	Friday	20 Mar	-9	30	30	1813141 56 33 45	1813120	1920	2	15
4	5		Wednes	6 April	-27	31	30	1813507 12 5 0	1813503	1	3	14
5	6		Monday	27 Mar	16	30	30	1813872 27 36 15	1813858	2	4	14
6	7	A	Friday	16 Mar	5	30	31	1814237 43 7 30	1814212	3	5	15
7	8		Thursday	4 April	-24	30	30	1814602 58 58 45	1814590	4	6	15
8	9	A	Monday	23 Mar	-13	31	30	1814968 14 10 0	1814960	5	7	14
9	1970		Saturday	13 Mar	2	30	30	1815333 29 41 15	1815305	6	8	14
1870	1		Friday	1 April	21	30	31	1815698 45 12 30	1815689	7	9	15
1	2	A	Tuesday	21 Mar	-10	31	30	1816064 0 43 45	1816045	8	1260	15
2	3		Monday	8 April	-20	31	30	1816429 16 15 0	1816427	9	1	14
3	4		Friday	28 Mar	17	30	31	1816794 31 46 15	1816781	1930	2	14
4	5	A	Wednes	18 Mar	7	30	31	1817159 47 17 30	1817136	1	3	15
5	6		Tuesday	6 April	-26	31	30	1817525 2 48 45	1817520	2	4	15
6	7	A	Saturday	25 Mar	-15	31	30	1817890 18 20 0	1817874	3	5	14
7	8		Wednes	14 Mar	3	30	31	1818255 33 51 15	1818228	4	6	15
8	9		Tuesday	2 April	-22	30	31	1818620 49 22 30	1818612	5	7	15
9	1980	A	Sunday	23 Mar	-12	31	30	1818986 4 55 45	1818967	6	8	15
1880	1		Saturday	10 April	30	30	30	1819351 20 25 0	1819351	7	9	14
1	2		Wednes	30 Mar	19	30	31	1819716 35 56 15	1819705	8	1290	15
2	3	A	Sunday	19 Mar	-6	30	30	1820081 51 27 30	1820059	9	1	15
3	4		Saturday	7 April	-27	31	30	1820447 6 58 45	1820413	1010	2	15
4	5	A	Thursday	27 Mar	16	30	30	1820812 22 30 0	1820798	1	3	14
5	6		Monday	16 Mar	5	30	31	1821177 38 1 15	1821152	2	4	15
6	7		Sunday	4 April	-24	30	30	1821542 53 22 30	1821536	3	5	15
7	8	A	Thursday	24 Mar	-13	31	30	1821908 9 3 45	1821890	4	6	15
8	9		Tuesday	13 Mar	2	30	30	1822273 24 35 0	1822245	5	7	14
9	1990		Sunday	31 Mar	-20	30	31	1822638 40 16 15	1822628	6	8	15
1890	1	A	Friday	21 Mar	-10	30	30	1823003 55 37 30	1822983	7	9	15
1	2		Thursday	9 April	-29	31	30	1823369 11 8 45	1823367	8	1300	15
2	3		Monday	28 Mar	17	30	30	1823734 26 40 0	1823721	9	1	14
3	4	A	Saturday	17 Mar	6	30	31	1824099 42 11 15	1824075	1950	2	15
4	5		Thursday	5 April	-25	30	30	1824464 57 42 30	1824459	1	3	15
5	6	A	Tuesday	26 Mar	-15	31	30	1824830 13 13 45	1824814	2	4	15
6	7		Saturday	14 Mar	3	30	30	1825195 28 45 0	1825168	3	5	14
7	8		Friday	3 April	-22	30	31	1825560 44 16 15	1825552	4	6	15
8	9	A	Tuesday	22 Mar	-11	30	30	1825925 59 37 30	1825906	5	7	15
9	1900		Monday	10 April	-30	31	30	1826291 15 18 45	1826280	6	8	15
1900	1		Saturday	31 Mar	19	30	31	1826656 30 50 0	1826645	7	9	15

NOTE

On the XIIIth Column of the Second Chronological Table.

IN the account which I have given of the Second Chronological Table, at page x of the Introduction, I was under the necessity of postponing what I had to say on the Carnatic *Fuzelce*, or Revenue year, for want of sufficient information on the subject. The cause of my hesitation arose principally from observing a difference of three years between the Bengal and Carnatic mode of reckoning in Revenue affairs, which (considering that the *Fuzelce* Era was introduced in both countries by the Mahomedan government) appeared to me to originate rather with some error in the sources of my information, than from a deliberate intention on the part of those who originally instituted it in the Mogul Empire.

After some research into the subject, I regret, however, to state that the results went only to establish the fact, without explaining the occasion of the difference. The reader must therefore remain satisfied with the following imperfect account of the Revenue periods observed in this part of India.

The Carnatic *Fuzelce* year is a Solar one, and its construction is exactly the same as that of the Tamil *Saura Mana*, being of $365^{\circ} 19' 31'' 15''$, with this only difference, that instead of beginning with the 1st of the Solar month *Chaitram* (B. Vaisacha) it was ordained by the Mahomedan government, to commence on the 1st of Audi (B. Sravana), and as it only applies to Revenue affairs, the *Civil* year alone is considered in accounts.

Thus the *Fuzelce* year which begins on the 1st Audi of the 4927th of the Cali yug (1748th Saca) answering to the 1235th of that Era, when referred to the European Kalendar, is found to commence on the 14th July 1825.

But we have seen at page ix of the Introduction that the Bengal corresponding Revenue year was the 1232d, and that it began with the *Moons' Wane* in the month of *Ashar* (Tamil *Anni*) (*). Hence the difference between the two accounts, amounts to two years, eleven months and some days: which difference may possibly proceed from some unknown cause, similar to that which has occasioned the discrepancy between the manner of counting the years of Jupiter (*Vrihaspati Chakra*) in Bengal, and in the Peninsula:

(*) How the Bengal *Parades* year, being a Solar one, can be made to begin, in succession, with any of the Moon's change taken at pleasure in twelve consecutive Lunar Synodical months, was not explained to me. If there was any mistake in the statement referred to, it can only be rectified in Bengal.

But an innovation has occurred in the *Calendar*, which (speaking as a *Chronologist*) I feel bound to predict, will create more confusion in the accounts of *remote times*, than the difference already adverted to. The Government of Fort St. George, taking probably the average Epoch of the beginning of the Mahomedan Fuzlee year (the same as that of the Tamil month *Adi*) for a great number of years and finding it to correspond with the 12th July, has directed its servants (with a view to greater regularity in revenue accounts) to fix in future the commencement of the Fuzlee year, on the above European date; so that agreeably to this arrangement, the *Revenue* is precisely equal to the European Civil year.

However, on casting a glance over the XIIth column under consideration, it will be immediately perceived that from A. D. 1600 to 1900 there is a difference of no less than *five days*, between the true and assumed beginning of the Fuzlee year, which will go on increasing at the rate of about two days in 120 Gregorian years, without there existing any periodical cause that might restore hereafter the supposed coincidence. A new *Æra*, which can be neither *Indian*, *Mahomedan*, nor *Christian*, will, therefore, be insensibly introduced, to perplex future *Chronologists*, who (excepting perhaps those who may chance to reside then under the Presidency of Fort St. George) will be unable to trace the institution to its true origin.

I am well informed that the inhabitants of these parts of India, although they do not object to the change ordered by Government when transacting with the Collectors, yet among themselves continue to abide by their old Fuzlee Calendar; I conclude therefore, that when a change was found decidedly advisable, it would have been preferable to have adopted at once the 1st of January, instead of the 12th of July of the European year, because it would have prevented ambiguity; for call the present *official Revenue* year by any name that you please, it can never be any thing else, but an *European* account of time, disguised under a foreign name.

On the manner in which the Fuzlee years are registered in the XIIth column, I have only to repeat what I have said on the other accounts of time exhibited in these Tables; that is to say, that the numeral of the year, registered on a line with any Christian year inserted in the 1st column on the left, indicates that which expires on the day and month inserted in the second division of the XIIth column; observing that from A. D. 1600 to 1750 the beginning of the Fuzlee years is given both in *Old* and *New Styles*; and from 1750 to 1900 in *New Style* only.

Thus the Revenue year which ends on the 1st July O. S., and 12th July N. S. of the Christian year 1701, is the 1110th, and from that date to the end of the European year it is the 1111th.

And that which ends on the 14th July N. S. of the Christian year 1829 is the 1234th, and that which begins on the said date is the 1235th.

N. B.—As the Fuzlee year is never used but for revenue purposes, the Natives only mind its beginning, but never care for its subdivisions into months, days, &c.



III.

GENERAL CHRONOLOGICAL TABLE exhibiting the years of the *Hijra* from Anno 1 to 1318, concurrent with the Christian years from A. D. 622 to 1900, and the date on which every Mohammedan year begins according to the European Calendar of the Julian and Gregorian Styles.

HEJRA, according to vulgar account - 15th July A. D. 622.
according to most Arabian Astronomers 12th July 62.

From Anno Hejra 1 to 81.
From Anno Domini 622 to 700, Julian Style.

From Anno Cali yugam 3723 to 3801.
From Anno 344 to 422 Saka.

VIII CENTURY.

Sunday 1. Etwat.				Monday 2. Peer.				Tuesday 3. Mungul.				Wednesday 4. Char Shumbol.				Thursday 5. Jannah Rhaat.				Friday 6. Jummah.				Saturday 7. Aul Hefah.			
Anno Hejra	A. D.	Begin-ning A. Hejra		Anno Hejra	A. D.	Begin-ning A. Hejra		Anno Hejra	A. D.	Begin-ning A. Hejra		Anno Hejra	A. D.	Begin-ning A. Hejra		Anno Hejra	A. D.	Begin-ning A. Hejra		Anno Hejra	A. D.	Begin-ning A. Hejra		Anno Hejra	A. D.	Begin-ning A. Hejra	
3	624	24 June		5 B	626	2 June		7 B	628	11 May		4	625	13 June		1	623	16 July		6	627	23 May					
11	632	25 Mar		8	633	1 May		15	636	14 Feb		12	633	13 Mar		9	630	20 Apr		14	635	25 Feb					
16 B	637	2 Feb		13 B	634	7 Mar		23	638	10 Nov		19.1	640	2 Jan		17	638	23 Jan		22	642	30 Nov					
19.1	640	2 Jan		21 B	641	10 Dec		31	645	17 Oct		20.3	648	21 Dec		25	645	28 Oct		30	650	4 Sep					
21.5		21 Dec																									
24 B	644	7 Nov		29 B	649	14 Sep		39	659	20 May		30	655	30 June		33	652	2 Aug		35 B	655	11 July					
27	647	7 Oct		37 B	657	19 June		47	667	3 Mar		44	664	4 Apr		41	661	7 May		38	658	9 June					
32 B	652	12 Aug		45	665	24 Mar		55	674	6 Dec		52.5	672	3 Jan		40 B	666	12 Mar		45 B	663	15 Apr					
40 B	660	17 May		52.5	672	3 Jan		63	682	10 Sep		53.2	679	27 Dec		48	669	9 Feb		51 B	671	18 Jan					
				53.2		27 Dec						60				43	669	9 Feb		41 B	671	18 Jan					
48 B	668	20 Feb		61	680	1 Oct		71	690	15 June		65 B	684	18 Aug		54 B	673	16 Dec		59 B	678	23 Oct					
50 B	673	25 Nov		69	688	6 July		70 B	692	21 Apr		68	687	18 July		57	676	14 Nov		67 B	680	23 July					
64	682	30 Aug		77	696	10 Apr		79	698	20 Mar		73 B	694	18 May		62 B	681	20 Sep		75	684	31 May					
72	691	4 June										81 B	700	26 Feb		70 B	689	25 June									
80	699	9 Mar														78 B	697	30 May									

81 B. - The letter B annexed to any year of the Hejra indicates that it is an intercalary one. And the Asterisk * and stroke — below, that it is the last of the Cycle of 30 years. The years Cali yugam and Saka are those about to end.

This Table is the first referred to in the Memoirs on the Lunar year of the Mohammedans; the 17th of the Kalu Saka kalim.

Third Chronological Table, continued.

VIIIth CENTURY.

From Anno Call ynam 2802 to 3001.
From Anno 623 to 722 Saca.

From Anno Hejira 82 to 184.
From A. D. 501 to 603.

Sunday 1.			Monday 2.			Tuesday 3.			Wednesday 4.			Thursday 5.			Friday 6.			Saturday 7.		
Anno Hejira	A. D.	Begin-ning A. Hejira	Anno Hejira	A. D.	Begin-ning A. Hejira	Anno Hejira	A. D.	Begin-ning A. Hejira	Anno Hejira	A. D.	Begin-ning A. Hejira	Anno Hejira	A. D.	Begin-ning A. Hejira	Anno Hejira	A. D.	Begin-ning A. Hejira	Anno Hejira	A. D.	Begin-ning A. Hejira
88	700	12 Dec	83	704	14 Jan	82	701	15 Feb	84 B	703	24 Jan	89 B	707	1 Dec	88 B	705	2 Jan	83	4 Feb	
90	714	16 Sep	93	711	19 Oct	60	708	20 Nov	86 B	705	2 Jan	97 B	712	3 Sep	94	712	7 Oct	91	9 Nov	
104	722	24 Jan	101	719	24 July	95 B	713	26 Sep	92 B	710	29 Oct	105	723	10 June	103	720	12 July	99	14 Aug	
112	730	26 Mar	100 B	724	26 May	98	716	25 Aug	100 B	718	3 Aug	112	731	15 Mar	110	728	16 Apr	107	19 May	
119 B	737	8 Jan	109	727	28 Apr	103 B	721	1 July	108 B	726	8 May	121	738	18 Dec	118	736	20 Jan	112	21 Feb	
123 B	742	4 Nov	114 B	732	3 Mar	111 B	729	5 Apr	116 B	734	10 Feb	129	746	22 Sep	126	743	25 Oct	123	26 Nov	
128	745	3 Oct	117	735	31 Jan	112 B	732	8 Jan	124	741	19 Nov	137	754	27 June	134	753	30 July	131	31 Aug	
123 B	750	9 Aug	122 B	739	7 Dec	127 B	744	13 Oct	132	749	20 Aug	145	762	2 Apr	142	759	4 May	136 B	7 July	
141 B	758	19 May	130 B	747	11 Sep	125	752	18 July	140	757	25 May	133 B	770	4 Jan	140	767	6 Feb	139	8 June	
140 B	763	16 Feb	128 B	753	16 June	142	760	22 Apr	142	765	27 Feb	134 B	771	24 Dec	138	774	11 Nov	144 B	11 Apr	
157 B	773	21 Nov	140 B	763	2 Mar	151	768	25 June	156	772	2 Dec	161	777	9 Oct	163 B	779	17 Sep	147	19 Mar	
165	781	26 Aug	133 B	770	4 Jan	159	775	31 Oct	164	780	6 Sep	166 B	782	15 Aug	171 B	787	22 June	152 B	14 Jan	
173	789	31 May	162	778	28 Sep	167	782	3 Aug	172	788	11 June	169	785	14 July	172 B	793	27 Mar	160 B	19 Oct	
181	797	5 Mar	170	786	3 July	174	791	10 May	180	796	10 Mar	174 B	790	20 May				168 B	23 July	
			178	794	7 Apr	183	799	12 Feb				177	793	18 Apr				176 B	28 Apr	
												182 B	798	22 Feb				181	1 Feb	

From Anno Hejire 185 to 233.
From A. D. 801 to 859.

IXth CENTURY.

From Anno Call yuam 5022 to 4001.
From Anno 221 to 324 Saca.

Sunday 1.			Monday 2.			Tuesday 3.			Wednesday 4.			Thursday 5.			Friday 6.			Saturday 7.		
Anno Hejire	A. D.	Begin-ning A. Hejire	Anno Hejire	A. D.	Begin-ning A. Hejire	Anno Hejire	A. D.	Begin-ning A. Hejire	Anno Hejire	A. D.	Begin-ning A. Hejire	Anno Hejire	A. D.	Begin-ning A. Hejire	Anno Hejire	A. D.	Begin-ning A. Hejire	Anno Hejire	A. D.	Begin-ning A. Hejire
180	801	8 Dec	180.2	802	10 Jan	181	806	17 Nov	185 B	801	20 Jan	185 B	805	27 Nov	186.2	807	10 Jan	187	6 Nov	
197	812	12 Sep	187 B. 6	816	13 Dec	188 B	811	23 Sept	188	803	20 Dec	188 B	813	18 Jan	189	816	11 Aug	190	11 Aug	
203	820	17 July	194	826	13 Oct	189	814	22 Aug	193 B	808	25 Oct	193 B	821	6 June	195	823	10 May	200	10 May	
215	828	22 Mar	202	837	25 July	204 B	839	28 June	201 B	816	30 July	201 B	850	11 Mar	211	834	12 Feb	208	12 Feb	
			210																	
230 B. 3	856	5 Jan	215 B	830	28 Feb	207	822	27 May	209 B	824	4 May	209 B	836	14 Dec	219	834	10 Jan	224	23 Nov	
221.1	810	20 Dec	218	833	27 Jan	212 B	827	2 Apr	217 B	832	7 Feb	220	843	18 Sept	227	841	31 Oct	231	28 Aug	
226	811	30 Sept	225 B	837	3 Dec	213.3	832	5 Jan	225	839	12 Nov	228	852	23 June	235	840	27 July	240	2 June	
234 B	848	3 Aug	231 B	845	7 Sept	228 B	842	10 Oct	233	847	17 Aug	235	860	28 Mar	243	857	30 Apr	245 B	8 Apr	
237	851	6 July	239 B	853	12 June	235 B	850	15 July	241	855	22 May	244.5	865	1 Jan	244	865	2 Feb	248	7 Mar	
242 B	856	10 May	247 B	861	17 Mar	244	853	19 Apr	249	863	24 Feb	252.2	875	6 Oct	249	872	7 Nov	252 B	11 Jan	
250 B	864	15 Feb	251.3	868	1 Jan	252	860	22 Jan	257	870	29 Nov	270	883	11 July	264 B	877	13 Sept	260 B	10 Dec	
258 B	871	18 Nov	263	876	14 Sept	260	873	27 Oct	265	878	3 Sept	275 B	888	10 May	267	880	12 Aug	261 B	15 Oct	
260 B	879	13 Aug	271	881	29 June	268	881	1 Aug	273	886	8 June	278	891	16 Apr	272 B	885	18 June	269 B	21 July	
273	887	23 May	279	892	3 Apr	276	889	6 May	281	893	13 Mar	283 B	896	19 Feb	280 B	893	23 Mar	277 B	25 Apr	
282	895	2 Mar	287.2	900	7 Jan	284	897	8 Feb	286 B	899	17 Jan				287.2	900	7 Jan	285	29 Jan	
			288 B. 6												288 B. 6					

Third Chronological Table, continued.

From Anno Calif yugam 4002 to 4101.
From Anno 823 to 943 Saka.

Xth CENTURY.

From Anno Hejira 290 to 391.
From A. D. 901 to 1000.

Sunday 1.			Monday 2.			Tuesday 3.			Wednesday 4.			Thursday 5.			Friday 6.			Saturday 7.		
Anno Hejira	A. D.	Begin- ning A. Hejira	Anno Hejira	A. D.	Begin- ning A. Hejira	Anno Hejira	A. D.	Begin- ning A. Hejira	Anno Hejira	A. D.	Begin- ning A. Hejira	Anno Hejira	A. D.	Begin- ning A. Hejira	Anno Hejira	A. D.	Begin- ning A. Hejira	Anno Hejira	A. D.	Begin- ning A. Hejira
290	902	5 Dec	305	907	12 Oct	302	904	13 Nov	309	901	16 Dec	301 B	903	24 Nov	306 B	908	30 Sept	303	2 Nov	
298	910	6 Sept	303	915	17 July	300	912	18 Aug	304 B	906	22 Oct	299 B	911	29 Aug	304	910	3 July	309	12 May	
306	918	14 June	311	923	21 Apr	301	913	7 Aug	297	909	30 Sept	307 B	919	3 June	312	922	9 Apr	317	14 Feb	
311	926	14 Mar	316 B	928	23 Feb	305 B	917	24 June	302 B	914	27 July	315	927	8 Mar	320	929	13 Jan	325	19 Nov	
321 B.3	933	1 Jan	319	931	24 Jan	308	920	23 May	310 B	922	1 May	323	934	11 Dec	328	930	18 Oct	333	24 Aug	
322.1	932	22 Dec	324 B	935	30 Nov	313 B	923	30 Mar	318 B	930	3 Feb	331	942	15 Sept	336	937	23 July	341	29 May	
* 330	941	20 Sept	324 B	935	30 Nov	313 B.3	933	1 Jan	326 B	937	6 Nov	339	950	20 June	344	945	27 Apr	349 B	4 Apr	
335 B	946	2 Aug	327	938	29 Oct	322.1	933	22 Dec	334	945	18 Aug	347	958	15 Mar	352	953	30 Jan	349	2 Mar	
338	949	1 July	332 B	943	4 Sept	329 B	940	6 Oct	342	953	12 May	350	965	7 Jan	357	970	4 Nov	354 B.7	7 Jan	
343 B	954	7 May	340 B	951	9 June	337 B	948	11 July	352	953	12 May	353	965	7 Jan	360	970	4 Nov	358.5	28 Dec	
351 B	962	9 Feb	348 B	959	14 Mar	345	956	15 Apr	350	961	20 Feb	363	973	28 Dec	366 B	975	10 Sept	367	7 Dec	
353 B	969	14 Nov	350 B	966	17 Dec	353	964	19 Jan	358	968	25 Nov	371	981	7 July	376	978	9 Aug	362 B	12 Oct	
367 B	977	10 Aug	364	974	21 Sept	361	971	24 Oct	365	976	30 Aug	370 B	986	13 May	373 B	983	15 June	370 B	17 July	
373	985	21 May	372	982	20 June	369	979	29 July	374	984	4 June	379	989	11 Apr	381 B	991	20 May	378 B	21 Apr	
383	993	26 Feb	380	990	31 Mar	377	987	3 May	382	993	9 Mar	384 B	994	15 Feb	388.9	992	2 Jan	386 B	29 Jan	
391	1000	1 Dec	388.9	998	3 Jan	385	995	5 Feb	390	999	13 Dec	387	997	14 Jan	390.110	993	23 Apr	390 B	29 Jan	
			392.5	998	23 Dec	385	995	5 Feb	* 390	999	13 Dec	387	997	14 Jan						

Third-Chronological Table, continued.

Primo Anno Hicinis 392 to 404.
Primo A. D. 1001 to 1102.

XIX CENTURY.

From Aug. Call sugar 410¢ to 420¢.
From Aug. 10¢ to 10½¢.

Sunday 1.			Monday 2.			Tuesday 3.			Wednesday 4.			Thursday 5.			Friday 6.			Saturday 7.		
Anno Hejire	A. D.	Begin- ning A. Hejire	Anno Hejire	A. D.	Begin- ning A. Hejire	Anno Hejire	A. D.	Begin- ning A. Hejire	Anno Hejire	A. D.	Begin- ning A. Hejire	Anno Hejire	A. D.	Begin- ning A. Hejire	Anno Hejire	A. D.	Begin- ning A. Hejire	Anno Hejire	A. D.	Begin- ning A. Hejire
399	1003	5 Sep	396	1003	8 Oct	393	1002	10 Nov	392 B	1004	18 Oct	392 B	1001	20 Nov	397 B	1003	27 Sep	394	1003	30 Oct
407	1010	10 June	404	1013	13 July	401	1010	15 Aug	400 B	1007	17 Sep	400 B	1009	23 Aug	405	1014	2 July	402	1011	4 Aug
415	1024	15 Mar	412	1021	17 Apr	406 B	1015	21 June	403 B	1012	23 July	408 B	1017	30 May	413	1022	6 Apr	410	1019	9 May
423	1031	19 Dec	420	1029	23 Jan	409	1018	20 May	411 B	1020	27 Apr	416 B	1025	4 Mar	421.6 422 B.3	1033	9 Jan	418	1027	11 Feb
431	1039	23 Sep	428	1036	26 Nov	414 B	1023	26 Mar	419 B	1025	31 Jan	421	1032	7 Dec	429	1037	14 Oct	426	1034	10 Nov
439	1047	28 June	435 B	1041	31 Aug	421.6 422 B.3	1030	9 Jan	427 B	1033	5 Nov	432	1036	11 Sep	437	1040	19 July	434	1042	21 Aug
444 B	1052	3 May	441 B	1049	5 June	430 B	1038	8 Oct	433	1051	15 May	438	1056	21 Mar	433	1061	26 Jan	442	1050	26 May
447	1056	2 Apr	449 B	1057	10 Mar	438 B	1046	8 July	441	1059	17 Feb	452 B.7 456.5	1063	4 Jan	461	1068	31 Oct	455 B.7 456.5	1058	23 Feb
452 B	1060	6 Feb	457 B	1064	13 Dec	440 B	1051	12 Apr	459	1066	22 Nov	454	1071	20 Sep	466 B	1073	6 Sep	458	1065	3 Dec
460 B	1067	11 Nov	465	1072	17 Sep	454	1062	13 Jan	467	1074	27 Aug	472	1079	4 July	469	1076	6 Aug	465 B	1070	6 Oct
468 B	1075	16 Aug	473	1080	22 June	462	1069	20 Oct	475	1082	1 June	480	1087	8 Apr	474 B	1081	11 June	471 B	1078	14 July
476 B	1083	21 May	481	1088	27 Mar	470	1077	25 July	483	1090	6 Mar	485 B	1092	12 Feb	477	1084	10 May	487 B	1094	21 Jan
484	1091	23 Feb	489.2	1095	31 Dec	478	1085	29 Apr	491	1097	9 Dec	488.5 489.2	1098	11 Jan	482 B	1089	16 Mar	485	1091	18 Apr
492	1095	28 Nov				485	1093	1 Feb				492 B	1099	31 Dec	490 B	1096	19 Dec			

Third Chronological Table, continued.

From Anno Hejira 403 to 527.
From A. D. 1861 to 1900.

XIIth CENTURY.

From Anno Call yugam 4292 to 4301.
From Anno 1923 to 1122 Sert.

Sunday 1.			Monday 2.			Tuesday 3.			Wednesday 4.			Thursday 5.			Friday 6.			Saturday 7.		
Anno Hejira	A. D.	Begin-ning A. Hejira	Anno Hejira	A. D.	Begin-ning A. Hejira	Anno Hejira	A. D.	Begin-ning A. Hejira	Anno Hejira	A. D.	Begin-ning A. Hejira	Anno Hejira	A. D.	Begin-ning A. Hejira	Anno Hejira	A. D.	Begin-ning A. Hejira	Anno Hejira	A. D.	Begin-ning A. Hejira
500	1106	2 Sep	497	1103	5 Oct	502	1108	11 Aug	499 B	1102	15 Oct	501 B	1107	22 Aug	498 B	1104	23 Sep	495	1101	25 Oct
508	1114	7 June	505	1111	13 July	510	1116	16 May	499	1103	13 Sep	500 B	1115	27 May	506 B	1112	28 June	503	1109	31 July
516	1122	12 Mar	513	1119	14 Apr	515 B	1121	22 Mar	504 B	1110	30 July	517 B	1123	1 Mar	514	1120	2 Apr	511	1117	5 May
524	1129	15 Dec	521	1127	17 Jan	518	1124	19 Feb	507	1113	18 June	525	1130	4 Dec	522.6 523 B.3	1128.3 1129	6 Jan	519	1125	7 Feb
532	1137	19 Sep	529 B	1131	23 Nov	522.6 523 B.3	1129.3 1130	6 Jan 25 Dec	512 B	1118	24 Apr	533	1138	8 Sep	530	1132	11 Oct	527	1132	12 Nov
540	1145	24 June	539	1134	22 Oct	531 B	1136	29 Sep	520 B	1126	27 Jan	541	1140	13 June	538	1143	17 July	535	1140	17 Aug
548 B	1150	30 Apr	544 B	1139	28 Aug	539 B	1144	4 July	528 B	1133	1 Nov	549	1154	18 Mar	546	1151	20 Apr	549	1148	29 May
548	1153	29 Mar	547	1142	27 July	547 B	1152	8 Apr	536 B	1141	6 Aug	557	1151	21 Dec	554	1150	23 Jan	551	1156	25 Feb
553 B	1158	2 Feb	549 B	1147	2 June	552.8 556 B.7	1160.3 1161	12 Jan 31 Dec	544	1142	11 May	565	1160	25 Sep	562	1160	28 Oct	555.3 556 B.7	1160.3	12 Jan
561 B	1165	7 Nov	550 B	1155	7 Mar	563	1167	17 Oct	562	1157	13 Feb	573	1177	30 June	570	1174	2 Aug	539	1163	30 Nov
569 B	1173	12 Aug	558 B	1161	10 Dec	571	1175	22 July	560	1164	18 Nov	581	1185	4 Apr	575 B	1176	8 June	564 B	1168	5 Oct
577 B	1181	17 May	566 B	1170	14 Sep	579	1183	26 Apr	568	1172	23 Aug	580 B	1190	8 Feb	578	1182	7 May	567	1171	4 Sep
585	1189	19 Feb	574	1178	19 June	587	1191	29 June	576	1180	26 May	589.5 590.3	1193.3 1194	7 Jan 27 Dec	583 B	1187	13 Mar	572 B	1176	30 July
593	1196	24 Nov	582	1186	24 May	595	1197	3 Nov	584	1188	2 Mar	594 B	1197	13 Nov	591 B	1194	16 Dec	580 B	1184	14 Apr
			589.5 590.2	1193.3 1194	7 Jan 27 Dec				592	1195	6 Dec	597	1200	12 Oct				598 B	1192	18 Jan
																		596 B	1190	23 Oct

Third Chronological Table, continued.

XIIIth CENTURY.

From Anno Hegire 598 to 697.
From A. D. 1201 to 1300.

From Anno Call yugam 4302 to 4401.
From Anno 1123 to 1222 Saka.

Sunday 1.			Monday 2.			Tuesday 3.			Wednesday 4.			Thursday 5.			Friday 6.			Saturday 7.		
Anno Hegire	A. D.	Begin-ning A. Hegire	Anno Hegire	A. D.	Begin-ning A. Hegire	Anno Hegire	A. D.	Begin-ning A. Hegire	Anno Hegire	A. D.	Begin-ning A. Hegire	Anno Hegire	A. D.	Begin-ning A. Hegire	Anno Hegire	A. D.	Begin-ning A. Hegire	Anno Hegire	A. D.	Begin-ning A. Hegire
604	1204	20 Aug	598	1201	1 Oct	603	1206	8 Aug	600	1203	10 Sep	602 B	1205	18 Aug	599 B	1202	20 Sep	604	1207	28 July
609	1212	2 June	606	1209	6 July	611	1214	12 May	605 B	1208	16 July	610 B	1215	23 May	607 B	1210	25 June	612	1215	2 May
617	1220	8 Mar	614	1217	10 Apr	619	1219	19 Mar	608	1211	13 June	618 B	1221	25 Feb	615	1218	30 Mar	620	1223	4 Feb
625	1227	12 Dec	622	1225	13 Jan	619	1222	15 Feb	612 B	1216	20 Apr	620 B	1228	30 Nov	622, 0 624 B, 3	1222	2 Jan	623	1230	9 Nov
633	1235	16 Sep	630	1232	18 Oct	623, 6 624 B, 3	1226	2 Jan	621 B	1221	24 Jan	634	1236	4 Sep	631	1233	7 Oct	636	1238	14 Aug
641	1243	21 June	635 B	1237	24 Aug	627	1229	20 Nov	639 B	1231	29 Oct	642	1244	9 June	639	1234	12 July	644	1246	19 May
646 B	1248	26 Apr	638	1240	23 July	632 B	1234	28 Sep	637 B	1230	2 Aug	630	1252	14 Mar	647	1249	16 Apr	652	1254	21 Feb
649	1251	25 Mar	643 B	1245	20 May	640 B	1242	1 July	645	1247	6 May	638	1259	18 Dec	655	1257	19 Jan	660	1261	26 Nov
654 B	1256	30 Jan	651 B	1253	2 Mar	648 B	1250	5 Apr	653	1255	10 Feb	666	1267	22 Sep	663	1264	24 Oct	669 B	1266	2 Oct
656 B, 3 657, 1	1258	8 Jan	659 B	1260	6 Dec	656 B, 3 657, 1	1258	8 Jan	651	1252	15 Nov	674	1275	27 June	671	1272	20 July	668	1269	31 Aug
662 B	1263	4 Nov	667 B	1268	10 Sep	664	1265	12 Oct	669	1270	20 Aug	682	1283	1 Apr	676 B	1277	4 June	673 B	1274	7 July
670 B	1271	9 Aug	675	1276	15 June	672	1273	18 July	677	1278	25 May	680, 5 691, 2	1291	4 Jan	679	1280	5 May	681 B	1282	11 Apr
678 B	1279	14 May	683	1284	20 Mar	680	1281	22 Apr	685	1286	27 Feb	693 B	1295	10 Nov	684 B	1285	9 Mar	689 B	1290	14 Jan
686 B	1287	16 Feb	690, 5 691, 2	1291	4 Jan	688	1289	25 Jan	693	1293	2 Dec	696	1298	9 Oct	687	1288	6 Feb	697 B	1297	19 Oct
694	1294	21 Nov	699	1299	28 Sep	696	1296	30 Oct	699	1299	2 Dec	696	1298	9 Oct	692 B 700 B	1292	12 Dec	697 B	1297	19 Oct
																	10 Sep			

Third Chronological Table, continued.

XIVth CENTURY.

From Anno Cali yugam 4402 to 4501.
From Anno 1223 to 1322 Sact.

From Anno Hejira 701 to 803.
From A. D. 1311 to 1400.

Sunday 1.			Monday 2.			Tuesday 3.			Wednesday 4.			Thursday 5.			Friday 6.			Saturday 7.		
Anno Hejira	A. D.	Begin-ning A. Hejira	Anno Hejira	A. D.	Begin-ning A. Hejira	Anno Hejira	A. D.	Begin-ning A. Hejira	Anno Hejira	A. D.	Begin-ning A. Hejira	Anno Hejira	A. D.	Begin-ning A. Hejira	Anno Hejira	A. D.	Begin-ning A. Hejira	Anno Hejira	A. D.	Begin-ning A. Hejira
702	1302	26 Aug	707	1307	3 July	704	1304	4 Aug	701	1301	6 Sept	703 B	1303	15 Aug	708 B	1308	21 June	705	1305	24 July
710	1310	31 May	715	1315	7 Apr	712	1312	9 May	706 B	1306	13 July	711 B	1311	20 May	716 B	1316	26 Mar	713	1313	23 Apr
718	1318	5 Mar	723.2	1323.2	10 Jan	720	1320	12 Feb	709	1309	13 June	719 B	1319	22 Feb	723.2	1323.2	10 Jan	721	1321	31 Jan
720	1320	8 Dec	725	1325	30 Dec	722 B	1322	18 Dec	714 B	1314	17 Apr	727 B	1327	27 Nov	732	1332	30 Dec	722	1322	5 Nov
734	1334	12 Sept	730 B	1330	21 Aug	728	1327	17 Nov	717	1317	16 Mar	735	1334	1 Sept	740	1339	9 July	737	1336	10 Aug
742	1341	17 June	730	1338	20 July	733 B	1332	22 Sept	723 B	1322	20 Jan	743	1342	6 June	748	1343	13 Apr	745	1344	15 May
750	1340	22 Mar	744 B	1343	25 May	741 B	1340	27 June	730 B	1339	25 Oct	751	1340	11 Mar	756	1345	16 Jan	753	1342	18 Feb
755 B	1354	25 Jan	747	1346	24 Apr	740 B	1343	1 Apr	738 B	1337	30 July	759	1357	14 Dec	764	1353	21 Oct	761	1350	23 Nov
757 B.3	1356	5 Jan	753 B	1351	28 Feb	757 B.3	1355	5 Jan	740 B	1343	4 May	767	1365	18 Sept	772	1370	20 July	766 B	1364	28 Sept
759.1	1356	26 Dec	758.1	1356	25 Dec	758.1	1356	25 Dec	758.1	1356	25 Dec	767	1365	18 Sept	772	1370	20 July	766 B	1364	28 Sept
763 B	1361	31 Oct	760 B	1358	3 Dec	766	1363	10 Oct	764	1353	6 Feb	773	1373	23 June	780	1378	3 Apr	769	1367	18 Aug
771 B	1369	5 Aug	768 B	1366	7 Sept	773	1371	13 July	762	1360	11 Nov	783	1381	22 Mar	786 B	1383	6 Mar	774 B	1372	3 July
779 B	1377	10 May	776 B	1374	12 June	781	1379	19 Apr	770	1368	16 Aug	790 B.7	1387	11 Jan	788	1386	2 Feb	777	1375	2 June
787 B	1385	12 Feb	784	1382	17 Mar	789	1387	22 Jan	778	1376	21 May	796 B	1393	6 Nov	793 B	1390	6 Dec	782 B	1389	7 Apr
794	1392	17 Nov	792	1389	20 Dec	797	1394	27 Oct	786	1384	24 Feb	799	1396	5 Oct	801 B	1398	13 Sept	790 B.7	1387	11 Jan
803	1400	22 Aug	800	1397	24 Sep				794	1391	29 Nov							791.5	1391	31 Dec
									802	1399	3 Sep							793 B	1395	16 Oct

Third Chronological Table, continued.

From Anna Högström 804 to 1008.
From A. D. 1501 to 1503.

XVII CENTURY.

From Anno Cali yugum 4322 to 4001.
From Anno 1323 to 1443 Sac.

Sunday 1.			Monday 2.			Tuesday 3.			Wednesday 4.			Thursday 5.			Friday 6.			Saturday 7.		
Begin- ning A. Hejira	A. D.	Anno Hejira	Begin- ning A. Hejira	A. D.	Anno Hejira	Begin- ning A. Hejira	A. D.	Anno Hejira	Begin- ning A. Hejira	A. D.	Anno Hejira	Begin- ning A. Hejira	A. D.	Anno Hejira	Begin- ning A. Hejira	A. D.	Anno Hejira	Begin- ning A. Hejira	A. D.	Anno Hejira
811	1408	808	808	1405	808	808	1402	805	810	1407	804 B	1401	804 B	800 B	1406	806 B	1403	806 B	1405	806 B
819	1416	816	816	1413	813	813	1410	813	815 B	1412	807	1404	807	817 B	1414	814	1411	814	1411	814
827	1423	824.2	824.2	1421	821	821	1418	821	818	1415	812 B	1409	812 B	824.2	1421	822	1419	822	1419	822
835	1431	832	832	1428	829 B	829 B	1425	832 B	835 B	1430	820 B	1417	820 B	833	1429	820	1426	820	1426	820
843	1439	840	840	1436	840	840	1433	840	831 B	1427	828 B	1424	828 B	841	1427	828	1424	828	1424	828
851	1447	848 B	848 B	1444	848 B	848 B	1441	848 B	836 B	1435	836 B	1432	836 B	849	1435	846	1432	846	1432	846
859	1455	856 B	856 B	1452	856 B	856 B	1449	856 B	844	1443	844	1440	844	857	1443	854	1440	854	1440	854
867	1463	864	864	1460	864	864	1457	864	852	1451	852	1448	852	856	1500	852	1497	852	1497	852
875	1471	872	872	1468	872	872	1465	872	860	1458	860	1455	860	873	1468	870	1465	870	1465	870
883	1479	880	880	1476	880	880	1473	880	868	1466	868	1463	868	881	1476	875 B	1470	875 B	1470	875 B
891	1487	888	888	1484	888	888	1481	888	876	1474	876	1471	876	886 B	1481	878	1473	878	1473	878
899	1495	896	896	1492	896	896	1489	896	884	1482	884	1479	884	890	1484	885 B	1478	885 B	1478	885 B
907	1503	904	904	1500	904	904	1497	904	895	1489	895	1486	895	894 B	1488	891 B	1480	891 B	1480	891 B
915	1511	912	912	1508	912	912	1505	912	903	1497	903	1494	903	897	1491	899 B	1493	899 B	1493	899 B
923	1519	920	920	1516	920	920	1513	920	906	1500	906	1499	906	902 B	1496	902 B	1496	902 B	1496	902 B

Third Chronological Table, continued.

From Anno Hejira 907 to 1009.
From Anno Domini 1501 to 1600.

XVIIth CENTURY.

From Anno Call yugam 4002 to 4701.
From Anno 1423 to 1522 Saca.

Sunday 1.			Monday 2.			Tuesday 3.			Wednesday 4.			Thursday 5.			Friday 6.			Saturday 7.		
Anno Hejira	A. D.	Begin-ning A. Hejira	Anno Hejira	A. D.	Begin-ning A. Hejira	Anno Hejira	A. D.	Begin-ning A. Hejira	Anno Hejira	A. D.	Begin-ning A. Hejira	Anno Hejira	A. D.	Begin-ning A. Hejira	Anno Hejira	A. D.	Begin-ning A. Hejira	Anno Hejira	A. D.	Begin-ning A. Hejira
914	1506	24 May	909	1503	26 June	914	1508	2 May	911	1505	4 June	908	1502	7 July	910 B.	1501	14 June	907 B.	1501	17 July
920	1514	26 Feb	917	1511	31 Mar	922	1516	5 Feb	916 B.	1510	10 Apr	913 B.	1507	13 May	918 B.	1512	19 Mar	915	1509	21 Apr
928	1521	1 Dec	924.2	1519	3 Jan	930	1523	10 Nov	919	1513	9 Mar	921 B.	1515	15 Feb	925.2	1516	3 Jan	923	1517	24 Jan
936	1529	5 Sep	933.6	1526	23 Dec	939 B.	1528	15 Sep	924 B.	1518	13 Jan	929 B.	1522	30 Nov	934	1527	23 Dec	931	1521	29 Oct
944	1537	10 June	941	1534	13 July	948	1531	15 Aug	937	1520	12 Dec	937 B.	1530	25 Aug	942	1533	2 July	939	1532	3 Aug
952	1545	13 Mar	949 B.	1539	19 May	953 B.	1536	20 June	932 B.	1523	18 Oct	945	1528	30 May	950	1543	6 Apr	947	1540	3 May
960	1552	18 Dec	949	1542	17 Apr	951 B.	1544	25 Mar	940 B.	1533	2 July	953	1540	4 Mar	958.6	1543	9 Jan	955	1548	11 Feb
965 B.	1557	24 Oct	954 B.	1547	21 Feb	958.6	1551	9 Jan	948 B.	1541	27 Apr	961	1543	17 Dec	966	1553	14 Oct	963	1555	16 Nov
969	1560	22 Sep	957	1550	20 June	967 B.	1559	3 Oct	956 B.	1549	30 June	969	1551	11 Sept	974	1566	19 July	971	1563	21 Aug
973 B.	1563	29 July	962 B.	1554	20 Nov	975	1567	8 July	964	1556	4 Nov	977	1569	16 June	982	1574	23 Apr	976 B.	1568	26 June
981 B.	1573	3 May	970 B.	1562	31 Aug	983	1573	13 Apr	972	1564	9 Aug	985	1577	21 Mar	990	1582	26 Jan	979	1571	30 May
989 B.	1581	5 Feb	978 B.	1570	5 June	986 B.	1578	10 Mar	980	1572	14 May	988	1580	17 Feb	994 B.	1584	30 Jan	984 B.	1576	31 Mar

GREGORIAN REFORMATION 4th OCTOBER 1582.

997 B.	1588	10.20 Nov	992.5	1583	24 Dec	991	1583	15.23 Jan.	990	1587	22 Nov	993.5	1585	24 Dec	995 B.	1586	2.12 Dec	992 B.	1584	4.14 Jan
1005	1590	16.26 August	994.2	1585	1583	999	1590	29.20 Oct.	994.2	1585	2 Dec	994.2	1585	3 Jan	998	1589	31 Oct	1000 B.	1591	9.19 Oct.
			1002	1593	1583	1007	1598	25 July	1004	1592	27 Aug	1001	1592	13.23 Dec.	1003 B.	1594	10 Nov	1008 B.	1599	14.24 July
								4 Aug			6 Sep	1003 B.	1597	28 Sep			8 Oct			
												1009	1600	4.14 Aug.			3.13 Jul			

† The first number indicates the Julian and the second the Gregorian initial date.

Third Chronological Table, continued.

From Anno Hejire 1010 to 1112.
From A. D. 1601 to 1700.

XVIII CENTURY.

From Anno Call yugum 4772 to 4801.
From Anno 1523 to 1622 Sica.

Sunday 1.				Monday 2.				Tuesday 3.				Wednesday 4.			
Anno Hejire	A. D.	Beginning A. Hejire O. S.	Beginning A. Hejire N. S.	Anno Hejire	A. D.	Beginning A. Hejire O. S.	Beginning A. Hejire N. S.	Anno Hejire	A. D.	Beginning A. Hejire O. S.	Beginning A. Hejire N. S.	Anno Hejire	A. D.	Beginning A. Hejire O. S.	Beginning A. Hejire N. S.
1013	1604	20 May	30 May	1010	1601	22 June	2 July	1015	1606	29 April	9 May	1012	1603	1 June	11 June
1021	1612	23 February	4 March	1018	1609	27 March	6 April	1023	1614	1 February	11 February	1020	1611	6 March	16 March
1029	1619	29 Nov.	8 Dec.	1026.2	1617	30 Dec. 1616	3 Jan.	1031	1621	6 Nov.	16 Nov.	1025B	1616	10 January	20 January
1037	1627	2 Sept.	12 Sept.	1027B.6	1624	19 Dec. 1617	29 Dec.	1030B	1626	12 Sept.	22 Sept.	1025	1618	9 Dec.	19 Dec.
1045	1635	7 June	17 June	1034	1632	4 October	14 October	1038B	1630	12 Sept.	22 Sept.	1033B	1623	15 October	25 October
1053	1643	12 March	22 March	1042	1640	9 July	19 July	1044B	1634	11 August	21 August	1041B	1631	20 July	30 July
1060B.3	1650	25 Dec 1649	4 Jan 1650	1050	1642	13 April	23 April	1047	1637	17 June	27 June	1049B	1639	24 April	4 May
1061.1	1651	15 Dec.	25 Dec.	1052B	1645	17 February	27 February	1052B	1642	22 March	1 April	1057B	1647	27 January	6 February
1066.B	1655	21 October	31 October	1058	1648	17 January	27 January	1052B	1642	22 March	1 April	1057B	1647	27 January	6 February
1069	1658	19 Sept.	29 Sept.	1063B	1652	22 Nov.	2 Dec.	1060B.3	1650	25 Dec 1649	4 Jan 1650	1063	1654	1 Nov.	11 Nov.
1074B	1663	26 July	5 August	1071B	1660	27 August	6 Sept.	1068B	1657	15 Dec 1656	25 Dec	1063	1654	1 Nov.	11 Nov.
1077	1666	24 June	4 July	1079B	1668	1 June	11 June	1075B	1665	29 Sept.	9 October	1073	1662	9 August	19 August
1082 B	1671	20 April	10 May	1087B	1676	6 March	16 March	1084	1673	4 July	14 July	1081	1670	11 May	21 May
1090 B	1679	3 February	12 February	1095	1684	10 Dec.	20 Dec.	1084	1673	8 April	18 April	1089	1678	13 February	23 February
1098 B	1686	7 Nov.	17 Nov.	1103	1691	14 Sept.	24 Sept.	1092	1681	11 January	21 January	1097	1686	18 Nov.	28 Nov.
1106 B	1694	12 August	22 August	1111	1699	19 June	29 June	1100	1688	16 October	26 October	1105	1693	23 August	2 Sept.

Third Chronological Table, continued.

XVIII CENTURY, continued.

Thursday, 5.				Friday 6.				Saturday, 7.			
Anno Hebrae	A. D.	Beginning A. H. 5570 O. S.	Beginning A. H. 5571 N. S.	Anno Hebrae	A. D.	Beginning A. H. 5572 O. S.	Beginning A. H. 5573 N. S.	Anno Hebrae	A. D.	Beginning A. H. 5574 O. S.	Beginning A. H. 5575 N. S.
1014 B	1606	9 May	10 May	1013 B	1602	11 June	21 June	1016 B	1607	18 April	28 April
1017	1608	7 April	17 April	1019 B	1610	16 March	26 March	1024	1615	21 January	31 January
1022 B	1613	11 February	21 February	1023, 2	1617	30 Dec 1616	9 January	1032	1622	23 October	2 Nov.
1020 B	1620	16 Nov.	26 Nov.	1027 B 5	1617	19 Dec 1617	29 Dec.	1040	1630	31 July	10 August
1028 B	1628	21 August	31 August	1033	1625	25 Sept.	3 October	1048	1638	5 May	15 May
1036 B	1636	26 May	5 June	1043	1635	28 June	8 July	1056	1646	7 February	17 February
1051	1643	23 February	10 March	1051	1643	2 April	12 April	1054	1653	12 Nov.	22 Nov.
1052	1654	4 Dec.	14 Dec.	1059	1649	5 January	15 January	1072	1661	17 August	27 August
1070	1660	8 Sept.	18 Sept.	1507	1656	10 October	20 October	1083	1669	22 May	1 June
1076	1667	13 June	23 June	1075	1654	15 July	25 July	1085 B	1674	26 March	7 April
1086	1675	18 March	28 March	1082	1672	19 April	29 April	1088	1677	24 February	6 March
1095, 1107	1684	31 Dec 1683	10 January	1091	1680	23 January	2 February	1092 B 7	1682	31 Dec 1681	10 January
1094, 5	1684	31 Dec 1683	31 Dec.	1099	1684	28 Nov.	8 Dec.	1094, 5	1682	31 Dec 1681	31 Dec.
1102	1690	27 Sept.	5 October	1099	1687	25 October	7 Nov.	1101 B	1689	9 October	18 October
1110	1698	30 June	10 July	1104 B	1692	2 Sept.	12 Sept.	1103 B	1697	10 July	23 July
				1107	1695	2 August	12 August				
				1112 B	1700	7 June	18 June				

* The new style was introduced among the Protestant States of Germany in A. D. 1700, when 11 days were omitted in the month of February.

Third Chronological Table, continued.

XVIIIth CENTURY.

From Anno Call yusum 4302 to 4401.
From Anno 1682 to 1799 Saca.

From Anno Hejira 1112 to 1215.
From A. D. 1701 to 1800.

Sunday 1.				Monday 2.				Tuesday 3.				Wednesday 4.			
Anno Hejira	A. D.	Beginning A. Hejira O. S.	Beginning A. Hejira N. S.	Anno Hejira	A. D.	Beginning A. Hejira O. S.	Beginning A. Hejira N. S.	Anno Hejira	A. D.	Beginning A. Hejira O. S.	Beginning A. Hejira N. S.	Anno Hejira	A. D.	Beginning A. Hejira O. S.	Beginning A. Hejira N. S.
1114	1702	17 May	28 May	1119	1707	24 March	4 April	1110	1706	25 April	6 May	1113	1701	28 May	8 June
1122	1710	19 February	2 March	1127.5	1713.5	27 Dec 1714	7 Jan.	1124	1712	20 January	9 February	1121	1708	2 March	12 March
1130	1717	24 Nov.	9 Dec.	1133 B	1723 B	10 Dec 1715	27 Dec.	1132	1719	3 Nov.	14 Nov.	1129 B	1714 B	6 January	17 January
1138	1725	29 August	9 Sept.	1143	1730	6 July	17 July	1140	1727	8 August	19 August	1129	1716	5 Dec.	16 Dec.
1146	1733	5 June	14 June	1151	1738	10 April	21 April	1145 B	1732	19 June	9 June	1131 B	1721	11 October	22 October
1154	1741	3 March	10 March	1159 B	1743 B	14 February	26 February	1148	1735	13 May	24 May	1137	1724	9 Sept.	20 Sept.
1161 B	1748 B	23 Dec 1747	2 Jan.	1150	1740	13 January	24 January	1153 B	1740	18 March	29 March	1142 B	1729	16 July	27 July
1162.1	1749.1	11 Dec 1748	22 Dec.	1164 B	1750	19 Nov.	30 Nov.	1161 B	1745 B	17 Dec 1747	2 Jan.	1150 B	1757	20 April	1 May
* 1170	1758	15 Sept.	26 Sept.	1167	1753	18 October	30 October	1162.3	1746.3	11 Dec 1749	22 Dec.	1158 B	1755	23 January	2 February
1175 B	1761	22 July	2 August	1172 B	1758 B	24 August	4 Sept.	1169 B	1756	25 Sept.	7 October	1165 B	1752	28 October	2 Nov.
1183 B	1769	30 April	7 May	1180 B	1766	20 May	9 June	1177 B	1763	1 July	15 July	1168 B	1752	28 October	2 Nov.
1191 B	1777	29 January	9 February	1188 B	1774	8 March	14 March	1185	1771	3 April	10 April	1174	1760	2 August	13 August
1199 B	1784	3 Nov.	14 Nov.	1196 B	1781	9 Dec.	17 Dec.	1193	1779	8 June	19 June	1182	1768	7 May	18 May
1207 B	1800	8 August	19 August	1204	1789	10 Sept.	21 Sept.	1201	1786	18 October	21 October	1190	1776	10 March	21 March
1215	1800	13 May	25 May	1212	1797	13 January	25 January	1209	1794	18 July	29 July	1198	1783	18 Nov.	26 Nov.

The BRITISH REFORMATION of the Calendar. In the year of Christ 1122 the Julian Calendar was abolished by Act of Parliament (24th George II.) and eleven days were expunged after the 2d of September of that year, by accounting the 24 to be the 14th day of the month. *Female Officers in British India, who concerning Indian, or Mohammedan dates, according before that Reformation, into European account, most frequently refer them to the Old Style, if they mean to have the date as then kept in England. However all the other Christian States of Europe (excepting Russia) followed the Gregorian Calendar before that Epoch.*

Third Chronological Table, continued.

XVIIIth CENTURY, continued.

Thursday 5.				Friday 6.				Saturday 7.			
Anno Hejira	A. D.	Beginning A. Hejira O. S.	Beginning A. Hejira N. S.	Anno Hejira	A. D.	Beginning A. Hejira O. S.	Beginning A. Hejira N. S.	Anno Hejira	A. D.	Beginning A. Hejira O. S.	Beginning A. Hejira N. S.
1115 B	1703	6 May	17 May	1120 B	1708	12 March	23 March	1117 B	1705	14 April	25 April
1118	1706	4 April	15 April	1127 B	1715	27 Dec 1714	7 Jan.	1125	1713	17 January	28 January
1123 B	1711	8 February	19 February	1128 B	1715	10 Dec 1715	27 Dec.	1133	1720	22 October	2 Nov.
1131 B	1718	13 Nov.	21 Nov.	1136 B	1723	20 Sept.	1 October	1141	1728	27 July	7 August
1130 B	1725	18 August	29 August	1144	1731	25 June	6 July	1149	1736	1 May	15 May
1137 B	1734	23 May	3 June	1152	1736	30 March	10 April	1157	1741	4 February	15 February
1142	1741	25 February	8 March	1160	1747	2 January	12 January	1165	1751	9 Nov.	20 Nov.
1163	1749	30 Nov.	11 Dec.	1163	1754	7 October	18 October	1173	1759	14 August	25 August
1171	1757	4 Sept.	15 Sept.	1176	1762	19 July	23 July	1181	1767	19 May	30 May
1179	1765	9 June	20 June	1184	1770	16 April	27 April	1186	1772	24 March	4 April
1187	1773	14 March	25 March	1192	1778	19 January	30 January	1189	1775	21 February	4 March
1194 B	1780	25 Dec 1779	5 Jan.	1200	1783	24 October	4 Nov.	1194 B	1780	25 Dec 1779	8 January
1195.5	1780	17 Dec 1780	28 Dec.	1205 B	1790	30 August	10 Sept.	1195.5	1780	17 Dec 1780	28 Dec.
1203	1788	21 Sept.	2 October	1208	1793	29 July	9 August	1197	1782	20 Nov.	7 Dec.
1211	1799	29 June	7 July	1213 B	1798	4 June	15 June	1202 B	1787	2 October	13 October
								1210 B	1795	7 July	19 July

Third Chronological Table, continued.

From Anno Hejira 1215 to 1318,
From A. D. 1801 to 1900.

XIXth CENTURY.

From Anno Call yugum 4602 to 5001,
From Anno 1722 to 1822 Saka.

Sunday 1.

Monday 2.

Tuesday 3.

Wednesday 4.

Anno Hejira	A. D.	Beginning A. Hejira O. S.	Beginning A. Hejira N. S.	Anno Hejira	A. D.	Beginning A. Hejira O. S.	Beginning A. Hejira N. S.	Anno Hejira	A. D.	Beginning A. Hejira O. S.	Beginning A. Hejira N. S.	Anno Hejira	A. D.	Beginning A. Hejira O. S.	Beginning A. Hejira N. S.
1223	1808	10 February	28 February	1200	1805	30 March	1 April	1217	1802	22 April	4 May	1222	1807	27 February	11 March
1231	1815	21 Nov.	3 Dec.	1208	1813	23 Dec 1812	4 Jan.	1228	1810	25 January	6 February	1230	1814	2 Dec.	14 Dec.
1239	1823	26 August	7 Sept.	1216 B	1820	12 Dec 1813	24 Dec.	1236	1817	30 October	11 Nov.	1235 B	1819	8 October	20 October
1247	1831	31 May	12 June	1214	1828	27 Sept.	9 October	1241	1825	4 August	16 August	1238	1822	6 Sept.	18 Sept.
1255	1839	5 March	17 March	1212	1836	6 April	18 April	1249	1830	10 June	22 June	1243 D	1827	13 July	25 July
1263	1846	8 Dec.	20 Dec.	1210	1844	10 January	22 January	1257	1833	9 May	21 May	1251 B	1835	17 April	29 April
1271	1854	12 Sept.	24 Sept.	1205 B	1848	15 Nov.	27 Nov.	1254 B	1838	15 March	27 March	1252 B	1843	20 January	1 February
1279 B	1859	19 July	31 July	1208	1851	15 October	27 October	1257	1841	11 February	23 February	1267 B	1850	26 October	6 Nov.
1279	1862	17 June	29 June	1273 B	1856	20 August	1 Sept.	1261.6	1845	20 Dec. 1844	10 Jan.	1276	1858	30 July	11 August
1284 B	1867	23 April	5 May	1281 B	1864	25 May	6 June	1262 B	1848	18 Dec. 1847	30 Dec.	1276	1858	30 July	11 August
1287	1870	22 March	3 April	1289 B	1872	28 February	11 March	1270 B	1853	22 Sept.	4 October	1283	1866	4 May	16 May
1292 B	1876	26 January	7 February	1297 B	1879	3 Dec.	15 Dec.	1278 B	1861	27 June	9 July	1291	1874	6 February	18 February
1299 B	1882	31 October	12 Nov.	1295	1887	7 Sept.	19 Sept.	1286 B	1869	1 April	15 April	1299	1881	11 Nov.	23 Nov.
1308 B	1890	6 August	17 August	1313	1895	12 June	24 June	1294	1877	4 January	16 January	1307	1889	16 August	29 August
1316 B	1898	10 May	22 May	1313	1895	12 June	24 June	1302	1884	9 October	21 October	1315	1897	21 May	2 June

Third Chronological Table, continued.

XIXth CENTURY, continued.

Thursday 5.				Friday 6.				Saturday 7.			
Anno Hejira	A. D.	Beginning A. Hejira O. S.	Beginning A. Hejira N. S.	Anno Hejira	A. D.	Beginning A. Hejira O. S.	Beginning A. Hejira N. S.	Anno Hejira	A. D.	Beginning A. Hejira O. S.	Beginning A. Hejira N. S.
1216 B	1801	2 May	14 May	1241 B	1806	9 March	21 March	1218 B	1803	11 April	23 April
1219	1804	31 March	12 April	1248 B	1813	23 Dec 1812	4 Jan.	1245 B	1811	14 January	24 January
1224 B	1809	4 February	16 February	1254 B	1818	12 Dec 1817	24 Dec.	1251 B	1816	19 October	31 October
1227	1812	4 January	16 January	1257 B	1821	16 Sept.	28 Sept.	1254	1818	24 July	5 August
1232 B	1816	9 Nov.	21 Nov.	1263	1824	21 June	3 July	1260	1820	28 April	10 May
1240 B	1824	14 August	26 August	1268 B	1829	20 March	7 April	1265	1823	21 January	12 February
1248 B	1832	19 May	31 May	1274 B	1835	18 Dec 1834	30 Dec.	1271	1828	5 Nov.	17 Nov.
1256 B	1840	23 February	5 March	1280 B	1841	3 October	15 October	1277	1834	10 August	22 August
1264	1847	27 Nov.	9 Dec.	1287	1848	8 July	23 July	1284	1837	16 May	27 May
1272	1855	1 Sept.	13 Sept.	1293	1854	12 April	24 April	1290	1839	17 February	1 March
1280	1863	6 June	18 June	1298	1860	16 January	28 January	1295	1842	24 Dec 1877	5 January
1288	1871	11 March	23 March	1301	1863	21 October	2 Nov.	1298	1845	14 Dec 1878	26 Dec.
1298	1879	24 Dec 1877	5 Jan.	1306 B	1868	15 August	7 Sept.	1298	1848	21 Nov.	4 Dec.
1298	1879	14 Dec 1878	26 Dec.	1306 B	1868	15 August	7 Sept.	1298	1848	21 Nov.	4 Dec.
1304	1886	18 Sept.	30 Sept.	1309	1871	25 July	7 August	1303 B	1843	28 Sept.	10 October
1312	1894	23 June	5 July	1314 B	1876	11 May	12 June	1311 B	1843	3 July	15 July
				1317	1879	10 April	12 May				

END OF THE CHRONOLOGICAL TABLE.

I SHALL conclude this work by giving a short method for finding the initial root and series (*Scota dina*) of any Terrestrial Solar year, past or to come, by means of the preceding Chronological Tables, and without reference to any other Rule whatsoever.

RULE.

I.

" If the proposed year is not to be found in any of the three centuries contained in the first Chronological Table, raise or lower it by adding to, or subtracting from its numeral, as many times 89 years, as will produce a year which is registered in the Table."

II.

" Take the root of the beginning of the year thus obtained, out of the XIIIth column of the first Chronological Table; and subtract, or add inversely from what you did before, as many times 12 21 137, as you have added or subtracted 89 years; and the sum or difference will give the *Scota dina* required."

The accompanying small Table will considerably abridge the above process. It is to be entered with the figures which express the number of times, that you have added or subtracted 89 years from the numeral of the proposed one, in order to raise or lower it, to one which is to be found in the Chronological Table; and the column of Roots will furnish that which is applicable to the question.

The following examples will suffice for shewing the use of these Rules and Table, in all possible cases.

EXAMPLE I.

Let us suppose that the years 1847, and 1764 of the Christian era, are not to be found in the first Chronological Table, although the contrary be the case.

Dispose the numerals of these years separately, and see how many times it may be necessary to subtract or add 89 years to obtain one which is registered in the Chronological Table. Suppose that in both cases it is one; then proceed as follows:

$$\begin{array}{r} \text{A. D. 1847} \\ \text{2d column small Table} \quad - \quad 89 \\ \hline \text{Difference} \quad 1758 \end{array}$$

$$\begin{array}{r} \text{A. D. 1764} \\ \quad + \quad 89 \\ \hline \text{Sum} \quad 1853 \end{array}$$

Number of Cycles.	Aggregate years in collective Cycles.	Roots.		
	Years.	G.	Y.	P.
1	89	1	21	15
2	178	2	42	30
3	267	4	3	45
4	356	5	23	0
5	445	6	44	15
6	534	8	7	30
7	623	9	28	45
8	712	10	50	0
9	801	12	11	15
10	890	13	32	30
11	979	14	53	45
12	1068	15	15	0
13	1157	17	30	15

Now as we have used only one cycle of 52 years, the root to be used in both cases is (34) 18 21 15 which is registered in the small Table opposite to 1 cycle, and 82 years.

Take out of the Chronological Table the initial roots which belong to the years 1758 and 1833 respectively, and proceed thus :

1758.					1833.					
	D.	C.	T.	P.		D.	C.	T.	P.	
Page xxiv.	(6)	46	52	30	Page xxi.	(1)	21	41	15	
Small Table, 3d col.	+	(0)	1	21	15	—	(0)	1	21	15
Roots sought,	(0)	48	13	45		(1)	23	0	0	

For a proof of which look in the same Chronological Table for the initial roots of the proposed years 1847, and 1764 at pages xiv and xvi; and you find them to be the same as above, shewing that the Tamil Solar year of the Cali yug 4948 ends, and 4949 (each answering to the above Christian years) begins on a *Sunday*, Syderal, and *Monday* Civil accounts; and that the year of the Cali yug 4858 ends and 4859 begins on a *Monday* Syderal and Civil accounts.

EXAMPLE II.

Wanted the initial feria or *Seota dina*, of the years of the Cali yug which concur with A. D. 2311 and 683.

Proceeding as we did before, we find that six cycles of 80 years suffice for lowering the first of the two proposed years; and thirteen, to raise the last, to years to be found in the Chronological Table. Referring therefore to the small Table with the numbers 6 and 13, in the first column, the rule will be,

A. D. 2311		A. D. 683	
Small Table, 2d col. for 6 cycles,	— 234	+	1157
	<hr/> 1777		<hr/> 1840

both of which indicate years to be found in our Chronological Table; whose roots at pages xiv and xvi will be found as follows:

	A. D. 1777.				A. D. 1840.						
	D.	C.	T.	P.		D.	C.	T.	P.		
Chronological Table, page xiv,	(3)	41	46	15	Page xvi,	(6)	29	35	0		
Small Table, 3d col. for 6 cycles,	+	(0)	8	7	30	12 Cycles,	—	(0)	17	38	15
Roots sought,	(3)	49	53	45		(6)	41	58	45		

which shews that the Solar year 5413 of the Cali yug which answers to A. D. 2311 began on a *Wednesday* Syderal, and *Thursday* Civil accounts; and that the year of the Cali yug 3783 which answers to A. D. 683 commenced on a *Friday* Syderal, and *Saturday* Civil accounts.

The proofs of these results may easily be found by expanding the same *Seota dina* by means of the Tables XLVIII, page 63 and Example page 63 of the Astronomical Tables referred to in the *Keta Sankalita*.

List of the Authorities, and Individuals who have patronised the Author, and subscribed to this Work. ()*

Collectively.

The Supreme Government of India.
The Government of Fort St. George.
The Government of Bombay.
His Majesty's Government of Ceylon.
The Board of Superintendence for the College of Fort St. George.
The College at Poona.
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Richard Clarke, Esq. Member of the Board of Revenue, and Senior Member of the Board of Superintendence for the College of Fort St. George.

(*) A part of the Edition of the *Kata Sankalita* having been placed at the Author's disposal, was the occasion of this subscription.

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